MAY 1946
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America's First Aeronautical Magazine

AVIATION

IN THIS ISSUE

DESIGN ANALYSIS OF REPUBLIC SEABEE

Presenting the first complete, authentic engineering article on the country's most widely discussed personal plane — an across-the-board story of interest to designers; to production, operation, and maintenance men; to dealers; and to owners.

★

GI FLIGHT TRAINING MEANS REAL BUSINESS

What every operator should know about new Veterans Administration interpretations - specifically how they point the way to promising air-training profits.

★

ENGINEERING DETAILS OF NENE TURBOJET

First complete data on this Rolls-Royce JP engine, Britain's most powerful, now rated at 5,000 lb. thrust.

★

FRANCE'S AIR INDUSTRY RISES AGAIN

Exclusive article revealing Tricolor's comeback since VE-Day, featuring illustrations and data on newly developed personal planes.

★

NORTHROP XB-35 FLYING WING

Giant bomber incorporates latest developments in radical design pointing to future high speed military and transport types.

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Fly to the Races

Indianapolis 500-Mile Speedway where America's great speed classic will be resumed May 28-31, after a four-year lapse. Flying enthusiasts all over the country are being urged to "Fly to the Races!"

Roscoe Turner (right) with Wilbur Shaw, president of the Speedway Corporation and former racing champion. Turner, president of N. A. T. A. and head of the Roscoe Turner Aeronautical Corp., says: "Pilots flying to the races will get real service for their planes plus a good time they won't soon forget!"

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FOR THE AVIATION INDUSTRY

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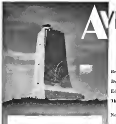

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Establishment of the AAF's guided missile experimental and development unit emphasizes the fact that rockets will continue as a very important weapon. Continuing our program on rockets, we take great pleasure in publishing a searching analysis of the power plant of the Nazi's V-2, which we must admit was a very potent weapon, written by a top-notcher in his field—Roy Healy, past president of the American Rocket Society and wartime rocket consultant to the Air Forces. Turn to page 63

The electric-hydraulic system battle probably never will be resolved—which is undoubtedly a good thing, for the competition will keep improvements in both systems coming along. Recently it's been something of a three-cornered affair, with pneumatic actuator installations finding new uses. So, to stimulate thought in all three phases as a means of giving designers additional tools, we offer the "Case For the Full-Pneumatic System" (page 68), a thoroughly documented study prepared by James L. Dooley, project engineer of the Harvey Machine Co.

WELCOME HOME, CHARLIE. Back in civvies after four years in the AAF, Lt. Col. Charles F. McReynolds has rejoined AVIATION as Pacific Coast Manager, with headquarters in Los Angeles. His initial assignment—when he was a first lieutenant—was as adjutant of the original glider training school at 29 Palms, Calif. He was soon transferred to Lake Field, Ariz., where he served in maintenance work for over a year before moving on to Combat Intelligence to get an overseas assignment with the then-top secret B-29 project. After training flights, he went to the CBI theater to organize intelligence procedures. He was the only Combat Intelligence Officer to accompany the Superforts on their first combat mission, and he made the first aerial photos of these ships in action. During the course of the war he flew twice around the world, made several trips over the Hump, and concluded his service with a tour of duty on Okinawa and thorough inspection trips in Japan studying bomb damage.

The flood of new airplanes continues—this month there are data on five new American types, three British, and five French. On pages 92 and 93 is the first information released on Northrop's giant XB-35 flying wing; on 94 the initial description of Piper's new four-placer; on 95 the dope on North American's four-place Navion; on 97 the details of the Thalman Special, unique for its use of geodetic construction; on 99 the data on G&A's XR-9 helicopter; and, on 100, illustrations and data on three British craft. Information on the French jobs—published here for the first time—forms an integral part of the feature (page 40) dealing with the new rise of the French aircraft industry after the long Nazi oppression.

And our complete coverage of the newest in jet propulsion continues—this month in the form of engineering details on the Rolls-Royce Nene, on page 73.

ALFRED Z. BOYAJIAN, Structures Project Engineer at Republic Aviation Corp., is a young man you'll hear a lot more about. For more than any other individual, he is the one, says Republic's President Marchev, whose theories, studies, tests and inventions have been responsible for the amplified structural design which has brought revolutionary attributes of low cost to the Seabee amphibian. What Boyajian has done, and how he did it, is told in Assistant Editor Irv Stone's great Design Analysis starting on page 45.

Down the Years in AVIATION'S Log

25 Yr. Ago (1921)—Post Office reports airmail division has carried 80 million letters in first 3 yr. operation at cost of $1,711,391, with 23 pilot fatalities. . . . Philippine airmail (Manila-Cebu and Manila-Zamboanga) is started, using Army seaplanes and native pilots. . . . Aeromarine West Indies Airways "Santa Maria" makes first Miami-Washington passenger-carrying flight in 17 hr. . . . Navy HS-2L seaplanes are converted into commercial carriers by Aeromarine Co. . . . Chain of ten landing fields for private flyers is laid out between Los Angeles and Salt Lake City by Aero Club of Southern California. . . . Army uses Curtiss Eagle as ambulance plane. . . . British Air Ministry appropriates $95,000,000 for RAF. . . . Western Airlines incorporated with capital of $100,000 . . . Bertaud flies Ansaldo A 300C from N. Y. to Chicago in 7½ hr. carrying 3 passengers and 500 lb. mail.

15 Yr. Ago (1931)—Telegraph companies open airline ticket agencies. . . . Service tests by airlines prove de-icer is successful safety device. . . . Air mail in 1930 totalled 8,005,657 lb. . . . Ludington Line, flying N. Y.-Washington route "Every hour on the hour" at first class railroad rates, has carried 25,863 passengers in 6 mo. . . . Hawke Crop Dusting Co., first to operate outside southern cotton belt, organized at Modesto, Calif. . . . NACA starts construction of seaplane test tank.

10 Yr. Ago (1936)—Bureau of Air Commerce tests Hammond Y low-cost plane. . . . UAL starts transcontinental Douglas DC-3 service with only two stops enroute. . . . Vought builds first monoplane scout bomber, XSB2U-1. . . . Taylor Aircraft produces first Taylorcraft. . . . PAA plans own chain of radio stations for trans-Atlantic flights. . . . Western Air Express completes 10 yr. of service without accident. . . . Hughes breaks Miami-N. Y. record in 4 hr. 21 min., flying Wright-engined Northrop Gamma. . . . Sikorsky S-43 breaks amphib altitude record at 27,950 ft. with Boris Sergievsky as pilot.

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Left: With conventional drilling, solid chips pack the drill flutes, causing scratched, out-of-round, and cracked holes. The drill must be withdrawn repeatedly to clear flutes and avoid drill breakage.

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UNITED STATES STEEL

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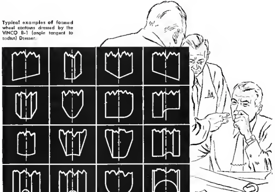

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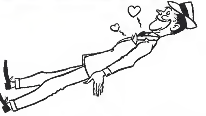

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HOUSING CAN COST TOO MUCH

EVERYONE in the United States wants our people, and particularly our war veterans, well housed quickly. Almost everyone, we believe, likes the vigor and imagination with which Wilson W. Wyatt, the housing expediter, is going about the job of mobilizing our housing resources.

No one, however, wants the veterans, or anyone else, to get a lot of severe economic headaches along with the housing. As it stands, the emergency housing program runs unnecessary risks of having such results.

Here are the reasons:

1. The principal opportunity the program offers to the veteran is that of buying a high-cost house where a chance to rent would, more often than not, meet his needs much better.
2. At the worst possible time, the program adds substantially to the dangers of a runaway inflation of the sort that inevitably ends in a crash.
3. Little is done to try to reduce the arbitrarily high costs of building, such as those resulting from restrictions imposed by labor unions and antiquated building codes.
4. By giving overriding priorities to unattainable goals of home construction, the program endangers a volume of industrial construction necessary to sustain full employment.

Needs of Veterans

First on the needs of the veterans. What many, if not most, veterans need is a chance to rent a place at a reasonable rental while they are getting shaken down in their postwar careers which in many cases are inevitably unsettled at this time. Essentially, what the "Veterans Emergency Housing Program" gives them is a chance to buy, for about $6,000, a house built along conventional lines and padded with much unnecessary labor and material cost.

But what are the alternatives? There are at least two. One is to put far more emphasis on more effective use of existing housing than the Wyatt program has thus far. The other is to see that the proportion of new rental units is much stepped up.

Incredible as it may seem, there are at present more than 2,000,000 vacant dwellings in the United States Many of them should be demolished. But many permit of relatively satisfactory temporary use. Many more single dwellings can readily be converted into comfortable multiple dwellings. The emergancy program assumes that only 350,000 dwelling units can be provided this year by these expedients, but it does not seem unreasonable to assume that this figure might be doubled by a vigorous drive. The result would be a better balanced emergency housing program, because it would provide more rental housing immediately and save critical building materials.

Of the new housing units contemplated by the Wyatt program, it is estimated that only about 20 per cent will be for rent. Before the war more than half of the homes in the United States were rented. That means that unless the Wyatt program is to create little less than a revolution in the terms on which homes are occupied, it must be revised to include a much higher proportion of rental units

To secure the result in the face of present high building costs special inducements will be required. They might be provided by allowing accelerated tax amortization of, say, half the construction cost over the next five years, together with rent ceilings high enough to make this form of investment attractive. This would, of course, call for higher rents, but the actual price to the veteran, in wce as well as money, might well be much less in the long run than if he bought an over-priced house now.

Too Easy To Pay Too Much

One of the mysteries of the Wyatt program is its general emphasis on measures to increase the supply of money with which to buy houses when the demand for houses is already at an all-time high. Some veterans may need special financial help, but the plan to give 90-95 per cent mortgages generally on new homes is not only unnecessary but positively dangerous By providing up to $3.5 billions of government-guaranteed credit for homes this year, and almost twice as much in 1947, the program will release an equivalent amount of individual savings to create further demand for goods and services. All that such generous mortgage terms will accomplish with certainty is a dangerous lengthening of the odds thet we will not avoid a boom and bust cycle of inflation.

If building codes were brought up to date and arbitrary union working restrictions were eliminated, the way would be paved for reductions in the price of standard houses which, it has been estimated, might run as much as 20 per cent. This would both give the buyer of a new house a far better run for his money, and also reduce the inflationary pressure created by the super-generous credit arrangements involved.

Getting anything done along this line is difficult, particularly because the restrictions are imposed hy tens of thousands of separate localities and organizations. Soma headway is being made. The local emergency housing committees being set up under the Wyatt program provide a means of doing much more. Far more steam must be put behind this aspect of the program, however, if its greatest potentiality for permanently constructive accomplishment is to be realized.

Crippling Essential Industrial Production

The goals set for emergency housing construction —1,200,000 new homes started this year and 1,500,000 started in 1947—are higher than any qualified authority thinks can be mat without crippling other essential construction. The reasons commonly assigned for such optimistic goals is that they are inspiring to those in the industry and soothing to those who want something tremendous done about housing

Under normal circumstances, relatively little damage might be done by such excessive goals which are a common feature of most Washington programs trying to elbow their way to the center of the national stage However, the emergency housing program carries with it top priorities for the materials to be used Consequantly, other essential construction will have to get along on whatever share of critical building materials will be left after all demands of homa builders have been satisfied.

The Civilian Production Administration estimates that output of important materials will fall far short of needs. It forecasts a 15 per cent deficit in lumber, 18 per cent in bricks, and 52 per cent in cast iron radiators. Hence, unless building materials output can be stepped up far more rapidly than now seems possible, a prohibitive squeeze will be put on industrial building to provide the materials needed for the Wyatt program. This would complicate unbearably the problems of sustaining full employment and getting the flow of production so important in avoiding the boom and bust route.

Perspective on the Housing Shortage

What is needed is an aggressive drive to get full production of building materials as rapidly as possible. Such a drive should concentrate on measures aimed at helping the industry remove the obstacles to all-out production rather than on such maasures as the subsidy plan which seems quite likely to succeed only in enmeshing the industry in more governmant controls. After making due allowance for the materials outlook and the needs for essential non-housing construction, housing goals should then be set as high as feasible. As matters stand, by setting construction goals before feasible material goals are determined, the cart is put before the horse.

There can be no doubt about the acuteness of the housing shortage and the necessity of a program commensurate with the magnitude of the problem. It also remains true, however, that the housing shortage for the nation as a whole is not quite as desperate as those who want the country to drop everything and go to building houses would have us believe.

During the war 3½ to 4 million new dwelling units were built or created by remodelling in other than farm areas. The number of families living in such areas increased by less than 3½ million. Even though some of this housing was located in remote places as an adjunct of war production works, the wartime increase permitted a margin for more housing per family at this time. Indeed, it has been estimated that the rate of doubling up is only about one-third as great as in 1940. The margin did not begin to suffice, however, to meet the needs of those millions of people particularly in the lower income groups who, thanks to rapid increases in income, can afford to have and insist upon having better housing than they have ever had before.

A rising standard of income which makes possible a new standard of housing for many people is a fine thing. Above all, it is important to see the veterans get the best possible break in housing.

Bnt Housing Can Cost Too Much

The Wyatt program has many good features. The emphasis on prefabrication, though perhaps over-optimistic, is hopefully modern. The emphasis on local collahoration in solving housing problems which are inevitably in large part local should lead to permanently valuable results. The vigorous mobilizing of 300,000 temporary dwellings to meet at high speed some of the most desperate shortage is all to the good.

The main trouble with the program is thet it does not pay enough attention to the economic havoc which may be created in the process of trying to meet its excessive goals. As a nation, we should be and are willing to pay a high price to get adequate housing. But the price will be too high if we:

1. Give the veteran a bad bargain hy selling him an over-priced house.
2. Cripple industrial production needed to create good jobs for veterans, and
3. Touch off a disastrous inflationary sequence in the process.

These pitfalls can be avoided. All of us, including the veterans, have a common interest in seeing that they are avoided.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Co., Inc.

THIS IS THE 47TH OF A SERIES

U.S.—THIRD-RATE AIR POWER

Speaking on Army Day, President Truman mads cogent reference to our defense requirements in the atomic age "No one knows yet," he said, "precisely what we shall need—in terms of infantry, artillery, pilots, paratroopers, ships, radar, planes, rockets, or bombs" These are sound words at a time when many people have formed dangerous conclusions as to the proportions of various types of weapons in our future defensive organization

But in this period of uncertainty about defensive needs, our fellow members of the United Nations are taking no chances with their air power Many of them are bolstering their commercial aviation with U S equipment acquired through lend-lease, hy purchase of our surplus, or, in a faw cases, hy orders for new aircraft Their aviation manufacturing industries are amply provided for by substantial military aviation appropriations

While it is difficult to decipher the budget figures of any nation, we know from the recent British "White Paper" on defense that England's recommended expenditures for air are higher than those asked for her navy In addition to the $1,024,000,000 directly allocated to air, there is an item of $1,896,000,000 requested for "supply and aircraft production". In the Royal Air Force appropriation is a request that $112,000,000 be earmarked for research These figures indicate clearly that Britain is teking no chances with her air power

Russia's fourth Five Year Plan (1946–50) calls for widespread expansion of air transport lines, a further raising of her defensive power, equipping of the armed forces with the nawest weapons, and insurance of technical development Research activities in atomic energy, cosmic rays, aerodynamics, and aircraft structures hold top places in the Soviet scientific program

For the first quarter of 1946 the French aviation budget is $107,340,000, of which $22,040,000 goes for commercial aviation, $8,263,000 for air armament, and $27,812,000 for an air force personnel of 95,000 officers and men An extensive program of jet propelled combat aircraft development is also underway, and several types of commercial planes are in the design stage

Other nations, too, are active The Dutch are tying their distent possessions with the homeland by a resumption and expansion of the air service rendered by KLM and KNILM So far they have hought or leased 85 surplus transport planes from us and eight new 4-engine craft have heen ordered

Belgium is dispersing part of her air activities in England and Switzerland. In 1946, $5,310,000 will be spent for flying schools and air force units stationed in England A wind tunnel is planned in Switzerland to supplement research facilities to be built at home. These activities will cost more than $12,000,000 Norway and Sweden likewise, are now busy rebuilding their air power. Argentina spent $152,280,000 on aviation in 1945

Against this background of air armament expenditures, 1946 finds our armed forces spending $500,000,000 for 2,000 new military aircraft including experimental types This will be one half of Britain's planned production New production transport planes on order for 1946–7 aggregate $125,000,000, and conversion contracts for transport planes amount to $40,000,000 Personal plane sales will amount to about $50,000,000, this year The total dollar volume for aircraft production this year will be approximately $700,000,000.

When Britain, in her desperate financial straits, sees fit to build twice as many military planes as the United States, it is time we profited hy the wisdom of our older and more experienced ally For more than half a century we depended upon British sea power to keep order in the Atlantic while we were content with a navy which proved inadequate to police the Pacific.

Now, on the first anniversary of VE-Day, we are without an international air force, advocated in these columns nearly three years ago The United Nations Organization cannot be any stronger than was the League of Nations if it is to be a debating society without the means to enforce its decisions. Until the future security of the world is assured, we would do well to maintain our dominant air power

The course of human events has reached the stage where we dare not depend upon anyone, no matter how well-intentioned, to share the problems of our defense. The tempo of atomic warfare does not leave time for the defenders to build an air force In modern warfare, delays and mistakes add up to swift liquidation

Our present rate of military plane procurement is far below the most conservative estimates of our needs Unless it is revised sharply upward we will quickly sink to third place—or lower—in international air power.

Leslie E. Neville

EDITOR

There's Real Business In That GI Flight Training Program

By PETER B. WOOLLEY

A former soldier shows how operators can benefit from new Veterans Administration interpretation of the law, and he presents vets' own ideas on how even more business can be developed.

VETERANS OF WORLD WAR II who are going to learn to fly under the educational privileges of the GI Bill of Rights are going to create plenty of business—and plenty of headaches—for the operators who do the teaching.

The GI Bill has not been changed since late last year. But the interpretation *has* been changed—so that the Veterans Administration now may pay up to certain limits for flight training for former soldiers, sailors, marines, wacs, waves, spars and women marines. The exact amounts to be paid for their training are determined by VA, with consideration of the eligibility of each individual veteran. Every vet is entitled to as much as $500 for each year of service, the maximum amount being $2,000.

The operator's problems start even before he can figure on receiving any income from veteran training. First, for example, he must secure approval of his state educational department, getting his organization recognized as an educational institution. Process for getting this approval varies with the states, but it is always the first step. And it should be clearly borne in mind that this is a state approval, not the federal approval granted by CAA.

With this state approval in hand, the operator's next step is to approach his local Veterans Administration office to discuss informally the procedure for securing its approval as a prelude to getting an okay from VA from headquarters in Washington. In these informal discussions the chief point to consider is the establishment of prescribed courses of study—for giving flight training under the GI Bill must be more carefully planned than procedures often set up for civilian training.

In general, courses of study set up by CAA-approved schools leading to CAA certificates will suffice, but it would be well for even CAA-approved schools to check with local VA offices to make certain their courses will qualify. Non-CAA-approved schools must, of course, set up adequate courses and it is believed advisable for groups of such schools applying to the same VA office to get together and present plans which are at least basically similar.

An effective means of establishing curricula is now under way in Pennsylvania, where the heads of the Pennsylvania Aviation Trades Assn. have taken the lead in working with the VA to establish courses similar to those afforded under the prewar CPT program. With this standard course approved, all members of the association will know exactly what they must offer for VA approval.

Flight training for former service men and women under GI Bill of Rights can mean plenty of profitable activity, but requires considerable al work before the profits roll in, as pointed out by Author Woolley in this article. It can be done, though—as shown in this photo, where Frank Pittinger (seated), president of Aviation Schools & Service, Inc., Blairstown, N. J., is seen signing Veterans Administration contract as (left to right) Treas. John Rothhauer, Sec. Helen Barrick and Vice-Pres. Harold H. Watlinger look on.

Experience has shown that the study course should be based on CAA requirements for certificates. For example, all required maneuvers should be prescribed for a certain lesson in the training course. Thus a student will learn familiarization on his first lessons, straight and level flight on the succeeding ones—and so on through the final sequence which he will fly for the examiner or inspector. Similar courses could easily be set up for each certificate in addition to that of private pilot, including refresher courses.

Once a group of schools has agreed on a standard course, such as is being done in Pennsylvania, each operator then applies for a contract. After the red tape has been unwound, a contract is either granted or refused. It's expected that contract refusals will be rare when properly set-up applications are presented, and such refusals, if any, will probably be based on some violation of safety rules or other really flagrant case.

It is agreed among leading operators that ground study should be included in any flight course. Such study is considered requisite because each student must pass a written examination for each certificate. He can be taught to fly, but he can't get the desired ticket unless he passes the exam. And if he doesn't get the ticket, the operator will be the first to feel his wrath.

Generally, people think of learning to fly as a part-time operation and, in a way, it is. But the less time one spends on it and the longer the periods between lessons, the more lengthy the overall time required to get a ticket. Therefore, subsistence allowances are available under the GI Bill.

To be eligible for full subsistence the vet must be spending at least 18 hr a week in pursuit of his studies. No one is likely to fly that much each week, but the hours will add up to that figure if the time devoted to classroom lectures and home study are included. This fact should always be brought out when applying to the VA.

It might well be asked: "How does the operator know how much time the student is putting in on his homework?" A question or two by an instructor can very easily determine whether the student has been working. Other indications. If the homework has really been done, the instructor's work in the air will be much easier and the student will show more rapid progress.

Once the courses are set up, the VA application made, and the final approval secured from Washington VA headquarters, the operator may start enrolling students.

But, before a student can be enrolled, he must first obtain a certificate of eligibility from his own local VA office. Note, however, that his VA office may not be the same as the operator's, due to differences in address. Local VA offices can be saved much time—and the operator some headaches—by making certain that no applicants are sent who should be taken care of through other offices.

One way the operator can help speed the process of getting students enrolled and started is to secure from the VA office a supply of Form 1950 blanks—a form that must be filled in and filed before the certificate of eligibility can be issued. Accordingly, someone in the operator's organization should become familiar with the problems connected with completing this form. There is always a chance that the prospective student will "louse it up," and if he goes to a new VA office he may well find someone thoroughly familiar with mechanical dental schools but who has much to learn about aviation.

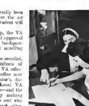
The ensuing snafu will only mean delays in getting the students enrolled and at their studies. But once the certificate of eligibility is in the operator's files, he can start the vet's training and know he'll get his money from VA.

That is the way the system works at present, but there is a strong feeling among many operators and most veterans (including the writer) that additional changes in the GI Bill's interpretation would make it easier for both the operators and prospective students.

First such change would be elimination of the requirement for state educational department approval. Many such state departments have had no experience in flight training—some even lack ground training experience, and thus are not equipped to pass on the merits of the cases.

There are really but two essential points: Is the veteran going to get his license? And is he going to be a careful, safe flyer? Most veterans feel that federal regulations alone can make certain that these tests will be met. Practically every veteran feels he should be allowed to make what he thinks is the best deal possible with the school of his choice.

Most veterans agree that a federal examiner should give oral examinations to each student after every 5 hr of flight time, and should make at least two check rides with the student during his training. These checks would not only make sure the instructor was doing his job properly and assure the student he was being properly instructed, but they would weed out those who are not adapted to safe flying.



One way to help get potentially profitable GI students enrolled quickly is to help them secure vital certificate of eligibility. Here Sec. Barrick helps Virginia Woodward, former Wac, fill out necessary forms prior to enrollment for both flight and A&E training.

Some veterans feel that if an inspector ruled that the student was capable of becoming a safe flyer, the school should be required to get him through his flight test regardless of the time it might take. They feel that if a man so checked can't get his private license in 35 to 40 hr., something is wrong with the instruction. They maintain that the vets will have considerably more than 40 hr paid for in the minimum schooling allowance.

An additional argument advanced for elimination of the state approval is that more schools could participate in the program, hence more students could be trained, and so the general benefit to the aviation industry as a whole would be increased.

Perhaps the fastest recurring question on the whole flight training program is this: "Why give flight training of any kind to veterans when there are so few jobs available in the industry, especially for men and women who are only pilots?"

Flight training under the GI Bill won't alter this situation much immediately, but it can have a healthy effect in the long run. By far the vast majority of air-interested veterans want to learn to fly because they believe that in the years to come Americans will be turning to their personal planes as they turn to their automobiles today—these vets no more count on being airline pilots than the hundreds of thousands of new automobile drivers licensed each year count on becoming truck or bus drivers.

The veterans who want to take flight training are looking forward to the days when they can own their own aircraft—and when they do they'll make a sizable market for manufacturers, distributors, and dealers.

To insure graduates' chances of getting desired certificates vet training should include ground school work, states Author Woolley. This class at Aviation Schools & Service gets lesson for next day's flight program.

New French Personal Planes Mark Revival of Tricolor Industry

Two-place Morane-Saulnier M-S 570 is a fully cantilever all-metal monoplane with retractable tricycle landing gear and a controllable pitch prop. With a 140-hp Renault top speed is stated to be 164 mph.

By ANDRE CHARRIOU, *Laureate of the Academy of Science*

First anniversary of V-E Day finds our war-disrupted ally back in the civil field with five new light craft—the Morane-Saulnier M-S 560 and 570, Starck A.S. 57 and 70, and S.U.C. 10 Courlis. Meanwhile, basic military and transport planning focusses on aviation strength for the future.

OUT OF THE DEVASTATION that swept France during the war, the occupation, and the liberation, the French are today diligently rebuilding their aircraft industry Some signs of this rebirth are evident in the several new, wholly French-designed craft that are now undergoing flight tests.

Two of these are by Morane-Saulnier —the M-S 560 and M S 570 Somewhat similar in appearance, they are both light low wing monoplanes with retractable tricycle landing gear The M-S 560 is a single seater powered by a Train 6D 01 engine of 75 hp., which gives the craft a top speed of 145 mph at 1,640 ft., a 129 mph cruising speed (70% power), and a 45-mph. landing speed Ceiling is given as 22,960 ft. and range as 620 mi Weight empty is 765 lb, gross weight 2,170 lb, and fuel capacity 24 5 gal Span is 28.7 ft., length 23 7 ft, height 7.21 ft., and wing area 126 9 sq ft.

The M S 570 is two-place powered by a 140 hp Renault 4 Pei. Top speed is given as 164 mph., cruising (70% power) 146 mph, and landing speed 49 mph Ceiling is stated to be 24,600 ft. and range 620 mi. Weight empty is 1,196 lb, gross weight 1,900 lb, and fuel capacity 42 2 gal. Span is given as 34 3 ft., length 28.1 ft., height 7.9 ft., and wing area 172.16 sq ft. Maximum rate of climb is given as 1,020 fpm.

Designed for Production

These designs, which were specially laid out for mass-production, utilize simplified structures and many castings. Construction is all-metal, including covering, and use is made of electrical welding of components. The cantilever wings are attached to the fuselage at four points, and the outer panels may be folded upward to facilitate storage of the craft. Hydraulically operated wing flaps of rather wide chord are fitted, and they can be depressed 50 deg Both craft have two-blade variable-pitch props. Radio receiving equipment is installed

Detail view shows wing folding mechanism on Morane-Saulnier M-S 560 Wings are hinged at three points and diagonal bar (see photo) probably acts as a lock while wings are up Note center-section flaps in down position

As yet in the design stage is the Courlis S U C 10, planned by the Societe d'Etudes et de Constructions Aero-Navales This is a four-place high-wing twin-boom pusher powered by either a 220 hp Renault 6-cyl engine or an 8-cyl 200 hp Mathis

Span is to be 37 7 ft, length 25 8 ft., height 8 7 ft, and main landing gear tread 7 5 ft Wing area is planned as 205 51 sq ft. Gross weight (Mathis engine) is given as 1,969 lb

Versatility Seen

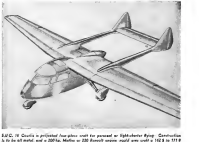
With Renault, top speed is estimated as 171.8 mph., and cruising speed as 153 1 mph.; while with the Mathis engine, top speed is expected to be 162.5 mph., and cruising speed 143 7 mph Depending upon payload, it is estimated that the S U C 10 will have a range of about 620–870 mi

Construction is to be all-metal, including covering of wings, fuselage, and tail booms An interesting feature is to be a unique door This would be a panel split horizontally and hinged at upper and lower sections Pushing the upper portion outward would simultaneously lower the bottom section, which incorporates a folding step Landing gear would be fixed tricycle A landing light is to be fitted in the craft's nose Conventional controls are to include wing flaps fitted to the inner portions of the outer wings only It is stated that the craft could be fitted with the necessary equipment for mail and light cargo pickup work

Another pair of light craft for the personal pilot are the Starck A S 57 and A.S 70 These designs are also very much alike, main differences being in engines and seating Construction is mainly of spruce, with fabric covering. The wings are attached to the fuselage at four points, and engines are mounted on electrically-welded tubes fitted with Silentblocs.

Various Engines Used

The A S 57 craft can be fitted with 60-75-95 hp engines These give this little side-by-sider top speeds of 111 7, 124 2, and 142.8 mph, respectively In the same order, cruising speeds are given as 102 4, 114 8, and 124 2 mph, landing speeds, 31, 38 5, and 38 6 mph, and ceilings are 17,056, 19,024, and 20,336 ft Range for all engines is 496 8 mi Span is 28 8 ft, length is 21 1 ft., and wing area 124 8 sq ft Empty weight for various engines is 627, 682, and 726 lb,



S.U C. 10 Courlis is projected four-place craft for personal or light-charter flying Construction is to be all metal and a 200 hp. Mathis or 220 Renault engine would give craft a 162 5 to 171 8 mph. top speed (Aviation sketch)

M S 560 is very much like 570 but is a single-seater powered by a 75-hp Train engine Top speed is given as 154 mph Weight empty is stated to be 765 lb Front view depicts craft propped up to show main landing gear's outward retraction

respectively. Gross weights are 1,265 lb, 1,320 lb., and 1,364 lb.

Fitted with a 45-60 hp engine, the single-seater A.S 70 is credited with the following performance Top speed (45-hp engine) 114 mph, (60 hp) 128 mph; cruising speed (45 hp) 103 mph, (60 hp) 114 mph stalling speed (45 hp) 33 5 mph, (60 hp) 34.1 mph Range for the former is stated to be 260 mi. and for the latter 229 mi., with ceilings at 20,336 ft, and 25,584 ft, respectively Empty weight is 404 lb (45 hp), 466 lb (60 hp), gross weight 682 lb (45 hp), and 704 lb (60 hp)

Resumé of Industry Developments

In June 1940, French aircraft and engine plants covered about 21,793,971 sq ft of floor space Then came the adversities of war, and by Sept. 1944 this space had been reduced to about 16,140,000 sq ft Out of 14 main plants, 10 had been crippled, some nearly completely destroyed In the main, airframe factories suffered more than engine plants

In 1938, the industry had some 10,000 machine tools at the outbreak of war, this number had risen to 13,100, and by June '40 the total was 24,000 Then, during the occupation, this figure was reduced when the Nazis stripped out equipment and sent it into Germany

However, after V-E Day the situation improved after return of some of this machinery from across the Rhine, so that now the French possess about 21,000 tools

Types Produced

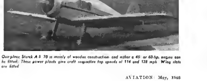
Some production resumed soon after the liberation The type of craft manufactured included several German models that had been made during the occupation, namely the Junkers Ju 52, Messerschmitt Me 108, Siebel Si 240, and the Fiesler Fi. 156 Storch Thereafter, production of French designs gradually got underway

These aircraft include the Caudron Oceland 449, a 6-place airliner, Languedoc 161, a 35-place four engine transport for South-Atlantic runs, Latecoere 631, a 72-ton 40-passenger trans-Atlantic flying boat, S O 90 and 91 for flying mail, S.O. 30R, a 30 passenger airliner, the S.E 2000, a 6-engine 50 ton flying boat, the Morane-Saulnier M S 472, a two seat military trainer, and the V B 10, a single place fighter

From Sept '44 through Oct. '45, the following promising record had been achieved 777 airplanes were produced, 267 planes repaired, 1,050 engines built, and 2,245 engines repaired.

Granted, these production figures are small compared with those of other nations, but they were achieved mainly by stop-gap methods. A prime aim was to give employment to aviation workers in order to retain their skills

Since the liberation, a great deal of planning has been focussed on development of an aviation industry for the future The nationalization program is being extended to cover more plants than formerly, so that even more private plants will be absorbed into the national group. Further dispersal of facilities, as protection against future attack from the air, is being considered, also extensive planning for greater use of mass-production techniques



One-place Starck A S 70 is mainly of wooden construction and either a 45 or 60-hp. engine can be fitted. These power plants give craft respective top speeds of 114 and 128 mph Wing slots are fitted

Caution Lights on Airline Earnings

By RAYMOND L. HOADLEY, *Financial Editor, Aviation*

In the air transport industry's current transition from "get set" to "go," consolidation of promised traffic expansions still lies ahead. And since the airline companies must meanwhile steer a careful course between the horns of a persistent dilemma—higher costs and lower fares—realism is advised in the outlook.

GRANTED, the airlines ranked very high in the lists of primary war earnings But factors fluctuate, and today the inevitable postwar readjustment has hit the lines with full force

Because of rising costs and lower rates and fares, the air carriers operated in red ink during the recent 1946 first quarter—the first such financial recession in two years This unfavorable showing, moreover, was made despite record traffic volume

Two years ago the airlines pulled right out of the red during the second quarter, when they soared on to record breaking levels Will they give a repeat performance? Among leading airline executives, there are two schools of thought regarding the industry's immediate prospects. And only when the operating results for the second and third quarters are in will we know for sure which group is right.

The airlines have just gone through a long "make-ready" period extending from November through March The deficits sustained in this five-months period were fully anticipated and have no real significance as far as the full year's operations are concerned Having now groomed themselves, the real question today is Just where will the industry go now? And this is a matter of considerable importance to airline investors, in view of the fact that airline stocks have been selling at rather fancy prices in relation to their earning power

Some recovery in the second quarter from the poor results experienced last quarter is expected by all trade officials. But there is a difference of opinion as to how far and how fast this recovery will extend. The head of one major line believes 1946 earnings will approximate, perhaps even exceed, those for 1945. However, another big line official thinks earnings of his company will be far below those of 1945

Certain it is that the old standby transport, the 21-passenger DC 3, will be approaching the uneconomic status as lower rates and fares impend Presumably, most lines will retire their veteran DC-3s soon after the newer Douglas and Lockheed planes are delivered.

The airlines have bought 146 four-engine aircraft of the DC-4 type (the military C-54), 15 new DC-4s direct from the Douglas factory, and 95 Lockheed Constellations Deliveries of this equipment have begun.

Question: As more and more transport planes come into service this year, where will the load factor stabilize? C R Smith, chairman of American Air lines, estimates that 1946 gross revenues of his company will increase 100% over 1945 If such a huge gain is general in the industry, there will be no need to worry about payloads dropping as low as 60% (as some fear) compared with the current 85 to 90% loads

Some airline executives, however, maintain they cannot let payload factors remain much above 70%, pointing out that it is impossible to give seats to everyone, inclusive of last minute applicants, if average payloads are held at 85% or more. Yet any substantial decline in payload below, say, 70% might be a serious affair United's President W. A Patterson is authority for the observation that at the present level of traffic it would cost a major airline about $1,500,000 annually in net before taxes for each decline of 5% in load factor.

Aside from a probable drop in payloads this year, there are other factors already operating to cut airline earnings United in one recent month had a net loss of $221,813 against a net profit of $458,095 in the like 1945 month In the same month National showed a loss of $82,000 against a profit of $13,000 a year ago, and Braniff had a loss of $21,000 against a $29,000 profit in the same 1945 month

Reason for these declines lies in increased wages (which amount to as much as 20% in some cases) and in the cost of converting and installing four-engine aircraft. The outlay for training additional personnel also is a major factor One line had a gain of 7% in revenue the first month of this year, but expenses were up 56%. Result was red ink compared with a nice operating profit achieved a year ago

So the airlines obviously are going through a test period It may be that air fares have come down too fast and too far to be commensurate with the

(*Turn to page 154*)

DESIGN ANALYSIS OF REPUBLIC SEABEE

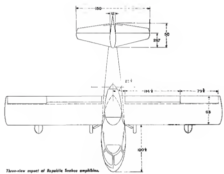
THE ENGINEERING of Republic Aviation Corp.'s Seabee amphibian marks a turning point in the aviation industry. Structurally, the craft represents such a reasonable—and necessary—departure from intricate conventional design, that its radical makeup—simplicity alone, embodying more than adequate strength characteristics, recommends it as a basic pattern for future engineering of aircraft—military, transport, and personal.

In substance, the fixed and movable airfoil structures of the Seabee are essentially ribless components comprising simple spar foundations covered by stiffened skin. The hull—almost a pure monocoque design—consists of a heavy gage shell with relatively few internal connecting members. And stemming from such highly simplified design is the all important factor of simplified production—the controlling factor in the ability to produce high value airplanes for low cost, without the requirement of large mass output heretofore considered necessary.

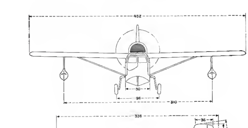
The Seabee project has unmistakably demonstrated that design complexity is the fundamental reason for high production costs, since there are narrow limitations to the production engineer's capability of cutting direct manufacturing labor charges when confronted with complicated subassemblies. And it has been shown that when the design is formulated, it must be predicated on attendant tooling and manufacturing problems. This is the first requirement for processing low-cost planes, hence, design and process engineers must work hand and

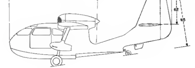
By IRVING STONE, *Assistant Editor, Aviation*

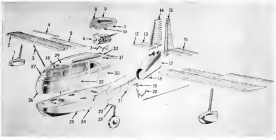
Veering sharply from complex and costly components, this new all-metal four-place amphibian design embodies a revolutionary degree of structural simplicity—the prime factor enabling Republic's engineers to achieve low-cost manufacture without need for huge volume. This notable stride forward is fully detailed in this construction-production study—20th in Aviation's explicit series.



Three-view aspect of Republic Seabee amphibian.







Exploded relation showing (1) Wing float (2) wing (3) wing brace strut (4) aileron, (5) flap (6) engine, (7) engine mount, (8) fixed top cowl (9) ravsable top cowl, (10) forward side cowl (11) rear side wrap-around cowl, (12) stabilizer, (13) elevator (14) fin, (15) rudder (16) tab (17) stern assembly (18) water rudder, (19) tail wheel, (20) structural fillet, (21) hull afterbody assembly (22) landing gear hull through shaft (23) elbow connecting hull shaft to strut, (24) foot step, (25) hull forebody assembly (26) cabin assembly superstructure, (27) bow door (28) side door, (29) crown window (30) cabin assembly rear primary structure (31) wing crosstie rod (32) firewall.

glove to develop designs that will permit high-speed production operations This involves a high degree of standardization of sections, hole sizes, and other structural details. Also, the design must be carefully studied to permit large individual sections to be drawn in dies, replacing a large number of small-part assemblies It is then the process engineer's function to develop the tooling to perform as many operations at one time as is possible, thus eliminating subsequent direct labor costs

In sharp contrast to the conventional aircraft structure, containing many small and interlocking component assemblies laboriously put together by hand, the simplified structure of the Seabee lends itself readily to rapid fabrication with equipment of the type generally used in the automobile industry—units such as mechanical presses, press brakes, and automatic screw machines And, additionally, large sections of the structure are assembled on automatic gang riveting machines

Using this type of fast-production equipment for the Seabee, each tool is designed for the maximum output For example, if a mechanical press is capable of 300 strokes per hour, the corresponding tool is designed for the same number of strokes—to produce an average of 300 parts per hour And to insure operation of equipment at maximum speed additional manpower is assigned, when such need is found to be necessary.

Assuming a run of 5,000 planes at a given rate, cost for the automotive type tooling is estimated to be approximately $300–$350 per lb of airframe, and since the airframe weighs about 1,100 lb., over all cost of production tooling is approximately $350,000 But it must be

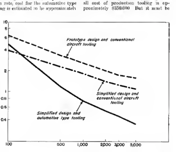
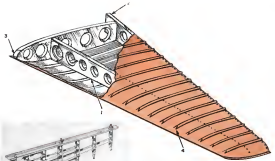
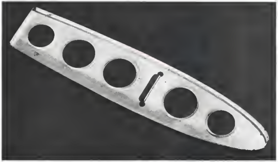


Chart showing distribution of stabilizer cost (labor, tooling and overhead—less material) in dollars per lb with prototype design and conventional aircraft tooling with simplified design and conventional aircraft tooling and with simplified design and automotive type tooling It is to be noted that latter tooling pays for itself in less than 200 craft

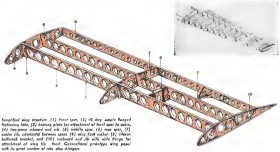


Simplified stabilizer seen here presents marked contrast to comparatively complicated conventional design shown at left. Simplified design components are (1) Front spar (2) rear spar (3) inboard end rib and (4) single-piece skin formed on camel back draw die with 1/4 in. stiffening beads serving to replace conventional frame members. Skin is also shaped to form integral tip, thus obviating need for outboard end rib. Assembly is accomplished almost entirely by automatic riveting



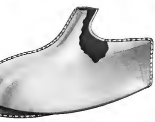
Simplicity of structural details is typified in this stabilizer inboard end rib—a single piece stamping provided with a slot for passage of front spar which is attached to rib via metal displaced from slot

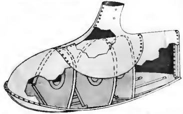
Camel back draw die for forming skins. This is temporary tool used until production unit is available, and is employed with steel mat (seen in background) which gives sharp impressions of the beads with hydraulic press utilizing rubber female. With mechanical press steel female will obviate need for mat



Simplified wing structure (1) Front spar, (2) 45 deg. simple flanged lightening hole, (3) bearing plate for attachment of front spar to cabin, (4) two-piece inboard end rib, (5) middle spar, (6) rear spar, (7) center rib, intercostal between spars (8) wing float socket (9) aileron bellcrank bracket, and (10) outboard end rib with wide flange for attachment of wing tip. Inset: Conventional prototype wing panel with its great number of ribs also stringers

Wing brace strut is single sheet turned on itself and joined on automatic riveting machine along outwardly faced flanges at trailing edge Extruded fittings at ends serve for attachment to hull and wing respectively





Seabee wing float (top) is fully monocoque structure fabricated of two pressings automatically riveted along juncture of outwardly turned flanges. Above: Conventional prototype float with rib members requiring hand riveting through access holes

understood that installation of the new tooling is predicated on a frozen airplane design—one that will be used for at least a year's production without any major design changes being made. Whereas no definite figures are available regarding cost per lb of airframe using conventional aircraft tooling on a comparable frozen run, it is approximated that the manufacturing cost (tooling, labor, and overhead) would be many times higher than the manufacturing cost with automotive type tooling.

In a study of the economies of utilizing automotive type tooling for the simplified (ribless) structure, distribution of stabilizer tooling, labor, and overhead costs was estimated over production runs of from 100 to 5,000 planes, and it was determined that the new tooling pays for itself in less than 200 craft.

Initial problem attendant with the choice of automotive type tooling was the selection of materials adaptable to fast production methods. After extensive investigation, 61SW was chosen for severely formed parts in which high strength was not important, and R-301W was selected for slight advantage in formability over other high stress material and partly to eliminate heat-treat operations in the manufacturing process. It is estimated that heat-treat per lb. of airframe adds 3c to 6c in direct labor cost.

As important feature of the Seabee production plan is a closely controlled parts flow time—three days from raw material to finished product—to eliminate stock rooms and attendant personal and paper work

Another major consideration lies in the procurement cost of items such as instruments, electrical switches, interior trim and hardware, and other equipment. In many instances it has been found that good, comparatively inexpensive, automotive type units can be used

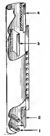
Seabee Design Philosophy

As a prelude to the structural analysis of the Seabee, it is interesting to outline, briefly, the considerations leading to, and the theory underlying, the simplified design

The prototype plane, which was completed in Nov. 1944, was built only to prove the general design. The craft was a three-place 175 hp all-metal amphibian monoplane using good but conventional structure throughout, and was an outgrowth of an original design by P. H. Spencer, development engineer.

Manufacturing cost considerations—price would have had to be almost twice the present price (just under $4,000) based on simplified design—prompted Alfred Marchev, Republic's president to direct an investigation to determine how airframe structures could be simplified to reduce manufacturing costs sharply He believed that extensive simplification could be achieved, with consequent great reduction in number of assembly components, while yet maintaining the high standards required in aircraft construction.

Alfred Z. Boyajian, structures project engineer at Republic, was assigned the task to redesign the Seabee airframe to meet reduced cost requirements. As a preliminary step, he reviewed (1) The evolution of conventional design, to ascertain why this type of structure had been adopted; (2) production time studies, made available from wartime experience, to establish what, in general, was causing manufacturing costs to be so high; and (3) stress analysis procedures, to determine what conceptions existed which might be altered to justify a vastly simplified structure.



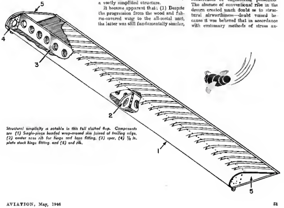
Wing float strut assembly. (1) Spacer tube for attachment bolts at float, (2) contour plate for float socket, (3) internal reinforcing channel, and (4) contour plate for wing socket.

It became apparent that: (1) Despite the progression from the wood and fabric-covered wing to the all-metal unit, the latter was still fundamentally similar, in basic pattern, to the former; (2) production complications arose because of the complex "egg box" structure—many internal interconnected members, in turn connected to the outside cover; and (3) the necessity for the retention of numerous rib components (as "irreplaceable" internal members of the conventional metal wing) had not been clearly established.

When engineer Boyajian's simplified—comparatively ribless—structural design was first proposed on paper it was subjected to much discussion in large conferences of engineering personnel The absence of conventional ribs in the design created much doubt as to structural airworthiness—doubt voiced because it was believed that in accordance with customary methods of stress an-

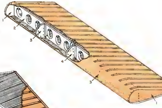
With the Significant Belief—

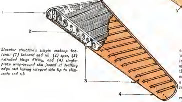
that a knowledge of the design philosophy and production methods behind the Seabee project belongs to the aviation industry, the management of Republic through Pres Alfred Marchev has made a notable contribution by welcoming investigation of its personal plane development by representatives of other aircraft manufacturers. And already a number of these men, as observers have visited Republic's Seabee division.



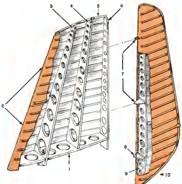
Structural simplicity is notable in this full slotted flap. Components are (1) Single-piece beaded wrap-around skin joined at trailing edge, (2) center nose rib for hinge and horn fitting, (3) spar, (4) ⅛ in. plate stock hinge fitting and (5) end rib.

Like flap full slotted aileron seen here also has single wrap-around skin Other details are (1) End rib (2) spar (3) nose rib carrying hinge, and (4) nose rib carrying horn Aileron is identical in cross-section to flap hence forming tools for latter may be used for aileron skin spar and rib





Elevator structure's simple makeup features (1) inboard end rib (2) spar, (3) extruded hinge fitting, and (4) single-piece wrap-around skin joined at trailing edge and having integral skin tip to eliminate end rib



Fin and rudder assembly (1) Fin bottom end rib, (2) wrap-around skin (3) front spar, (4) center spar, (5) integral skin tip, (6) rear spar, (7) rudder hinge fitting (8) combination hinge and horn fitting (9) spar, and (10) wrap-around skin joined at trailing edge It is contemplated to build rudder of l. & r. clamshell sections joined along external flanges at both leading and trailing edges (around entire periphery) thus eliminating spar.

alysis, the proposed simplified structure was considered to be probably deficient in strength requirements It was considered, generally, that other than a rib there was no structural member deemed capable of transferring airload shears in a chordwise direction to the bending-resistant spars

Boyajian's theory was that if the cover of a stressed skin wing were sufficiently stiffened, thus creating a heavy torque box, it should be possible to transfer such airload shears with a minimum of internal structure He arrived at this conclusion after reasoning that the conventional practice for a stressed skin wing, wherein a section is isolated and analyzed as an independent structure, was not justified, since it was assumed that the other portions of the overall structure did not contribute any vital additional strength characteristics to the isolated section.

True, an isolated ribless section would deflect under airload because of absence of shear rigidity, and would give a large torsional displacement with respect to the end ribs. But a torque box, for example, comprising the stressed skin leading edge would offer appreciable restraint to such torsional displacement. Further, Boyajian believed that the leading edge cell and the aft cells would serve, in some degree, as beams in bending between end ribs, and that the secondary spars would also act so He also reasoned that individual heads on leading edge skin would serve partially as truss members pinned at the leading edge

In effect, Boyajian's proposal was a new application of the theory of stress analysis—a radical departure from conventional practice—which had to be substantiated by static test as the design proceeded, since the stress in the simplified structure could not be adequately calculated

In the face of doubt and disagreement, but encouraged by Mr Marchev, the simplified design took shape unit-by-unit, as hand-built specimens, for test purposes.

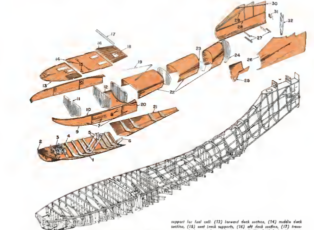
As an initial step in the development program, the conventional prototype stabilizer—a fair example of a costly all-metal structure consisting of spars, ribs, and stringers—was selected for experimental simplification Aim was to effect radical manufacturing cost reduction without sacrificing strength-weight characteristics and serviceability

Stabilizer Design

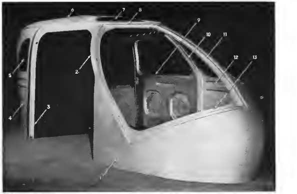
As evolved, the simplified stabilizer structure—approximately 6 ft. long, with average chord of 1½ ft.—consists of front and rear spars and inboard end rib All material is R-301W, requiring no heat treatment

Front spar—only internal member of the stabilizer structure—is an .025 channel section with lightening holes having simple flanges for stiffness, and rear spar is an .091 channel section. Both spars have straightline taper and can be made on a mechanical press or on a bending brake A flat bearing plate is attached at inboard end of each spar for connection to the hull structure.

Inboard end rib—.025 gage—has simple flanged lightening holes A slot in the rib allows the front spar to pass through without interrupting the rib member, and attachment of latter to spar is made via the metal portion displaced from the slot It is to be noted that the skin forms the outboard connec-



At top is seen exploded relation of hull structure. Extreme simplicity of this design is evidenced by comparison with conventional hull structure shown above Hull components are (1) Forebody bottom assembly, (2) T shaped keel extrusion, (3) battery support, (4) hat-section stiffener, (5) landing gear brace channel (6) keel splice gusset, (7) forebody side skin, (8) opening for landing gear hull shaft, (9) chine (10) Z-section longeron, (11) watertight bulkhead, (12) plastic sheet support for fuel cell (13) forward deck section, (14) middle deck section, (15) seat track supports, (16) aft deck section, (17) transverse angle for attachment of wing strut fitting, (18) fuel cell cutout, (19) cabin attachment angle (20) first step, (21) afterbody bottom assembly (22) afterbody upper section skins, (23) tail wheel auxiliary bulkhead (24) tail wheel watertight bulkhead (25) second step (structural fillet), (26) stern skin (27) transverse stiffeners, (28) longitudinal stiffener, (29) diagonal stiffener, (30) channel stiffener for fin cutout, (31) channel for attachment of stabilizer rear spars, and (32) rear closure bulkhead.



Cabin superstructure frame setup: (1) Right bow panel (2) double front door post (3) rear right door post (4) rear side panel (5) side window (6) monopiece roof (7) crown window, (8) crown bow frame (9) left side door (10) single front door post (11) center bow frame (12) left bow panel and (13) lower bow door post. Fabrication simplicity is typified in cabin fixed superstructure where side panel is blanked from a single piece and formed with stiffening beads and contour in one operation. Cabin rear primary structure attaches to rear side skins of superstructure and encloses baggage compartment ducked by firewall.

tion for the spars of the stabilizer unit.

On the conventional stabilizer, skin was .020 24ST Alclad, whereas the simplified stabilizer—having the same outline—has skin of .025 R-301W. External stiffening beads, serving to eliminate the internal framework of the conventional structure, are ¼ in. deep by 4 in. on centers and are not considered objectionable as speed-impeders. And it is also felt that the external beading lends a decorative touch to the plane surfaces. Actual test on the prototype plane, with and without beading (beads were simulated by wooden strips attached to wings and tail surfaces), showed a reduction of but 3 mph. at high speed—a loss offset by a reduction of 2 mph. in stalling speed.

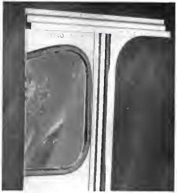
An example of the type of tooling utilized for fabricating the stabilizer skin—tooling which is typical for fabricating the beaded skins of the wing, other fixed surfaces, and movable surfaces—is the forming die. This is a camel-back draw die which forms the beads with necessary contour and depth. Draw flash is die-trimmed to give the skin its size and outline. Final operation in a beading die forms the camel-back into the leading edge of the structure by folding the skin back from the bulge.

In assembly, front spar is attached to inboard end rib as a first operation. This unit is then placed within the skin envelope whose sections have been preassembled on an automatic riveting machine with a single row of rivets. Accessibility from the open end at the rear of the envelope permits automatic riveting of the latter to the front spar and end rib. Next, the rear spar is installed and automatically riveted to the skin to form the rear closure of the structure. And the tip is formed with an external flange, also automatically riveted.

Thus, aside from attachment of stabilizer hinges (bolted) and other minor hand operations, the entire assembly is automatically joined—a fairly typical procedure for all the airfoil structures on the Seabee. This simple method of assembly is in marked contrast to the complicated, manual, slow and costly procedure involved in the fabrication of the conventional structure.

Static test of the simplified stabilizer showed about 10% higher strength over the conventional prototype unit, and it also disclosed very satisfactory rigidity. And most important—since it made possible such fast and cost-saving production methods (replacement price of stabilizer panel complete assembly, including attachment parts, is expected to be

Section through cabin structure at rear window and door (inside view, left side, looking forward). Rubber S-extrusion for retaining window is cemented to latter and to panel cutout margin and serves as weather seal, vibration damper, and trim. Combination angle-and-Z section crown bow member attaches to side skin and door post gusset portion.



under $35)—was the justification of a new approach in stress analysis.

Following is a comparison of design and production factors of the simplified and conventional stabilizers:

	Conventional	Simplified
Parts	42	9
Man-Hours	14.2	2.7
Rivets	521	160
Weight (lb.)	13	13

Now that the application of this simplified design had proved satisfactory for the stabilizer, it was decided to test the construction principles on a much larger unit—the wing panel.

Wing Structure

Conventional prototype wing was a good, typical airfoil structure of 24ST—a tapered, full cantilever unit consisting of ribs, spars, and stringers. Here, again, there were so many interlocking components, all largely inaccessible to automatic machinery, that in the main it had to be assembled almost entirely by hand; hence, it was very costly. Manufacturing of the many detail components was comparatively simple, representing only about 5% of total wing fabrication time; the other 95% was almost all assembly time.

The simplified wing is a rectangular-planform constant-thickness structure, externally braced by a single strut. Reasons underlying the change from tapered to rectangular planform were as follows:

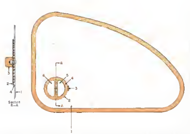
(1) Skin becomes a rectangular sheet, and in bending it to the form of the wing, material losses ordinarily occasioned with a tapered wing are avoided.

(2) A single forming tool can be used for all skin sections on both l. & r. wing panels, whereas on a tapered wing, each skin section requires a separate forming tool, and a different set of tools is required for the opposite wing.

(3) A single tool can be used for fabricating spars in l. & r. panels.

(4) Exact width strip-stock can be used for the spars, since the flat pattern

View of cabin through right side door revealing roomy interior. Seat back cushions are detachable for use as life preservers.



View from outside of cabin side panel window showing simple plastic ventilator installation in closed position (1) Window, (2) ventilator, (3) ventilator handle, (4) rubber gasket, (5) cutout in window and (6) cutout in ventilator.

of the unit is rectangular. This avoids material losses and additional operations required for the tapered spar.

(5) Rectangular-planform wing permits flaps and ailerons, and their hinges and brackets, to be interchangeable l & r, thus eliminating the need for separate tools and material losses attendant with the tapered design.

All of these considerations are extremely important in a simplified structure. In contrast, small differences between two assemblies of a conventional design (such as non-interchangeability of l. & r. skin sections) were not of much consequence, since this condition required only a new set of parts and tools—representing but a negligible portion of total manufacturing costs which were, largely, consumed in assembly handwork. However, in the simplified design—in which handwork has been greatly eliminated—small differences which require additional tools and prevent the use of components interchangeably, add considerably to the cost of the structure.

Simplified wing framework consists of 3 ribs and 3 spars. Ribs are approximately 8½ ft on centers and spars are approximately 15 in. on centers. Inboard rib is a 2-piece member—nose rib and after portion. Center rib is made up of 3 pieces intercostal between spars. Outboard rib is a single member providing for the attachment of wing tip by incorporating a wide flange.

Front spar, supplying about 90% of wing bending strength, is an .064 channel constant throughout the span and having straight flanges turned on a bending brake. Extruded angles of 14ST are nested in top and bottom flanges and extend from inboard end approximately three-quarters of the span towards the tip. A simple forging is used on the inboard end of the spar to make attachment to the cabin structure. Attachment for brace strut is accomplished with another forging at the center rib.

Middle spar—essentially a false spar—is an .032 channel member fabricated in a manner similar to the front spar, but has no angle attachments.

Rear spar is a simple .051 channel member having a forging at the inboard end for attachment to the cabin structure.

Between front and middle spars, at about one-quarter the distance from the middle to the tip, is the wing float supporting structure consisting of two pressings forming a socket for the float strut.

All spars are of R-301W material. Lightening holes have simple 45 deg flanges formed without subsequent heat treating. Because of severe forming, ribs are fabricated of 24SO, and are subsequently heat treated. Rib lightening holes have deep drawn flanges.

Wing skin, with beading similar to that on the stabilizer, is R-301W—.032 on inboard half and .025 on outboard half. Skin sections are pressed on a camel-back draw die, similar to the method used for the stabilizer skin.

In assembly of the wing, skin sections are first spliced on an automatic riveting machine to form a large envelope. Spars are installed progressively, beginning with the front spar, and riveting is done on an automatic riveter afforded access to interior of envelope from rear opening. Rivets are driven through both upper and lower skins and through spar flanges at same time. In about 6 min. Wing tip is quickly installed on outboard rib with sheet metal screws and self locking sheet metal nuts.

External wing brace strut is a single piece of .091 R-301W turned on itself to provide a streamlined section joined at the trailing edge, on an automatic riveter, along outwardly turned flanges. Extruded fittings on each end of the brace strut carry one bolt for attachment to wing and hull, respectively.

Wing floats are R-301W .051 skins formed in a novel manner. Each float is of fully monocoque construction consisting of l & r pressings (clamshells) joined at the plane of symmetry along outwardly turned flanges adaptable for external automatic riveting. The strut connecting the float to the wing slips into a neck section provided in the pressings. Complete float assembly consists of but five parts—two skin sections, two bearing plates for strut bolts, and a drain plug—and can be fabricated in 15 min. This is in sharp contrast to conventional wing floats with numerous bulkheads which are fastened to the skin by reaching through access holes and driving each rivet by hand.

In this simplified wing design, notable lightness is achieved. Complete with flaps, ailerons, brace struts, and miscellaneous fittings, it weighs but 1.45 lb per sq ft—unusual, considering that the average wing loading is 16 lb per sq ft.

Basic makeup comparisons of conventional and simplified wing structures are listed below:

	Conventional	*Simplified*
Parts	114	30
Man-Hours	280	10
Rivets	2,627	882
Weight (lb)	150	110

In static test, the wing sustained a load of 115%, and in torsional rigidity was four times greater than CAA requirements. Another unusual characteristic of the wing structure was that no skin ripples or buckles appeared up to 100% of design load—a condition rarely achieved in a conventional metal wing structure.

These very satisfactory results obtained with the large wing structure justified the application of this theory of

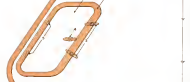
FUNDAMENTAL DESIGN DATA

GENERAL	
Model	RC-3
Type	Amphibian monoplane
Seating	4-place
Construction	All Metal
Flight instruments	Basic CAA and ball bank
Radio (two way)	Tower and range
Propeller	Ground adjustable (Reversible pitch propeller optional)
POWER PLANT	
Make and model	Franklin 6AS 215-B8F
Hp and rpm	215 at 2,500
Fuel used at cruise	12.5 gal. per hr
PERFORMANCE	
High speed	120 mph
Cruising at 75% power	103 mph
Landing speed	58 mph
Climb first minute	700 fpm.
Range at cruising	560 mi. (75 gal.)
Full load condition	
Takeoff land	580 ft.
Takeoff water	1,065 ft.
Takeoff time water	18 sec.
Landing run land	400 ft.
Landing run, water	700 ft.
WEIGHT	
Gross	3,000 lb.
Empty	1,950 lb
Useful load	1,050 lb
LOADING SELECTIONS	
2 people (pilot & passenger)	340 lb
75 gal fuel (5.6 hr at cruise)	450 lb.
3 gal. oil	20 lb
Baggage	240 lb.
Total	1,050 lb
3 people (pilot & passenger)	510 lb.
71 gal. fuel (5.3 hr at cruise)	426 lb.
3 gal. oil	20 lb.
Baggage	94 lb.
Total	1,050 lb.
4 people (pilot & 3 passengers)	680 lb.
45 gal fuel (3.5 hr at cruise)	270 lb.
3 gal. oil	20 lb
Baggage	80 lb
Total	1,050 lb.
DIMENSIONS	
Span max.	37 ft. 8 in
Length, max.	28 ft.
Height, max.	9 ft. 7 in.
Wheel span main gear	8 ft.
Cabin width interior	46 in.
Cabin height interior	50 in
Cabin length interior	110 in
Baggage compartment	20 cu. ft.
Draft loaded	18 in.

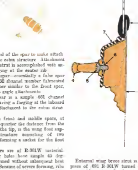
COMPARATIVE DATA

Conventional vs Simplified

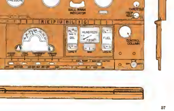
	Conventional Prototype	Simplified Design
Passengers	3	4
Wing area (sq. ft)	171	188
Gross weight (lb.)	3,800	3,000
Weight empty (lb.)	2,150	1,950
Airframe weight (lb.)	1,200	1,140
Airframe parts	1,800	450
Airframe fabrication time (man-hours)	2,500	200
Airframe tool cost at 5,000/yr	$1,750,000	$350,000



Details of cabin clear-view panel installation. (1) Clear-view panel, (2) plastic frame, (3) lock knob (4) pull handle, and (5) plastic hinge pin



Part section through side door: (1) Door skin (2) rubber S-extrusion window retainer, (3) window, (4) pull to handle (5) sheet metal screw (6) sheet metal nut and (7) interior trim



General aspect of instrument panel. Manifold pressure gage (not standard equipment) is used in connection with controllable pitch propeller installation (optional). In addition to units designated on panel other devices installed are pulls for parking brake carburetor mixture and carburetor heat signal lights for landing gear position, and microphone.

simplified and cost-lowering design. And as a result of the attendant production advantages, cost of replacement for a wing panel complete assembly, including attachment mechanism, is expected to be under $250.

Movable Surfaces

Except for size and shape, the full-slotted flaps, ailerons, elevators, and rudder are fundamentally identical in construction. Each consists of a single beaded skin folded upon itself and joined at the trailing edge, and each has a single stamped channel spar member near the leading edge.

Flaps and ailerons have round-nose end ribs with outwardly turned flanges to afford easy access for automatic riveting.

Elevator has only one rib—inboard end—bolted to the operating torque tube extending between L & R units. No outboard end rib is employed because the tip is formed from the skin as a continuation of the trailing edge. The latter is cut out for a flat stock trim tab at the inboard end, the tab being attached by piano hinge.

Upper and lower tips on rudder are fabricated similar to elevator tip, hence obviating need for end ribs.

On the flap there are three ⅛-in. flat stock hinge fittings. Two are mounted on the end ribs, and the third fitting, which includes an operating horn, is mounted on a center nose rib.

On the aileron there are two ⅛-in. flat stock hinge fittings and a separate horn, which are attached to intermediate nose ribs.

On the rudder and elevator the spar supports T-shaped extruded hinge fittings.

Since the cross-section of the aileron is identical to that of the flap, it is possible to use the flap-forming tools to fabricate the aileron skin, spar, and ribs.

Flap, aileron, elevator, and horizontal stabilizer units are interchangeable with respective airplane installations. Approximate dimensions are: Flap, 9½ ft. long by 16 in. by 4 in. deep at spar; aileron, 7 ft. long by 16 in. by 4 in. at the spar; elevator (tapered in planform), 6 ft. long by 20 in. at max chord, tapering to 10 in. at tip, by 3 in. average depth at spar; and rudder (double tapered in planform) 8½ ft. long by 18 in. at max. chord by 4 in. average thickness at spar.

Replacement prices for the various complete assemblies, including attachment mechanisms, are expected to be under these figures: Flap, $35; aileron, $50; elevator, $25; and rudder, $25.

Control system is conventional cable installation. Cockpit control is standard wheel arrangement with provision for utilizing removable duplicate wheel for co-pilot, who has rudder pedals but no brake pedals.

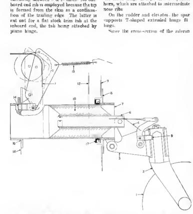
Hull Structure

The hull, designed so as to permit a major portion of riveting to be done on automatic machinery, consists of three separate assemblies—forebody, afterbody, and cabin. Assembled, it has six watertight compartments—3 in the forebody, 2 in the afterbody, the stern being the last compartment.

Forebody is comprised of four subassembly units—deck (cabin floor), two sides, and bottom. Deck is made in three sections—forward, middle, and aft. Forward section is a single .051 24SO pressing, subsequently heat treated, and reinforced with 3 hat-sections (2 transverse, 1 longitudinal) supporting cockpit flight controls. Edges of this section has an upwardly turned flange for assembly to the sides by riveting.

Deck middle section is .025 R-301W stiffened by four longitudinal hat-sections supporting the front seats and landing gear brace channels. Margins of middle section are also upwardly flanged for attachment to sides and to front deck section. Attachment to rear deck is by a lap joint. Between the middle section and the sides is a ⅞ in. R-301W Z-section longeron which becomes a single angle where it overlaps (for about 10 in.) the front and aft sections of the deck.

Deck aft section is a single .051 24SO beaded pressing, subsequently heat treated, and having upwardly turned flanges on the sides. At the rear, the aft section of the deck overlaps the forward skin of the afterbody and also the step bulkhead. A cutout is provided in the aft deck section for access to the fuel cell (located between middle and aft bulkheads).



Tail gear installation (1) Wheel, (2) fork, (3) yoke lower arm, (4) yoke upper arm (5) lock pin (6) piston, (7) hollow retracting shaft (8) bearing (9) second step bulkhead (10) rubber shock absorber secured to shaft interior and piston exterior (11) retracting cable (wound around shaft), (12) shockcord (13) spring (14) down lock pin, (15) bearing, (16) forward bulkhead support and (17) spring loaded rubber water seal. During landing application of ground load to wheel (1) causes leftward displacement of piston (6) and rubber (10) then acts in shear to absorb force imposed. In retraction cable (11) rotates shaft (7) to nest wheel alongside stern

First two watertight bulkheads—.040 24SO beaded pressings, heat treated—are sandwiched between the flange junctions of the deck skins.

Sides of forebody are .064 R-301W made up in three sections flanged outwardly at the chine, where it joins the bottom subassembly flange.

At this bow, forward of the front bulkhead, the bottom consists of L & R .072 61SW skins (made in a draw die). From the forward bulkhead to the step, the .051 R-301W skin (made on a bending brake) is reinforced by 7-hat section transverse stiffeners having greatest depth of about 4 in. at the keel. On the underside of the chine is an external reinforcing angle extending from the forward bulkhead to the step.

The keel—a T-shaped 14ST extrusion provided with drain plugs for each watertight compartment—runs aft of the first step for splicing to the keel of the afterbody.

Various simple structures within the forebody serve to support the battery, hydraulic pump, and landing gear mechanism, and also provide anchorage for safety belts.

Afterbody—hull section between steps—is comprised of an upper section and the bottom subassembly units. Upper section is fabricated from three pieces of .051 R-301W, each developable from a flat pattern joined by simple lap joints. Rivets through the lap joint between first and second skins pick up the flange of the forward watertight beaded bulkhead.

Afterbody bottom is a single sheet of .051 R-301W (formed on a bending brake) reinforced by four hat-sections, as in the forebody.

An indication of the sturdiness of the hull bottom structure is that after more than 600 water landings, no dishing or skin ripples were observed.

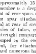
The bulkhead at the second step supports the tailwheel and is formed as an .040 24SO beaded pressing, subsequently heat treated. At the lower portion of the bulkhead is a bearing plate reinforcement for attachment of the tailwheel. Flanges of the bulkhead face forward and are sufficiently wide to provide a foundation for a butt joint between afterbody rear skin and stern skin. The sphere is further reinforced at the bottom by an .051 R-301W structural fairing.

The stern consists of two subassemblies—L & R halves—comprising a clamshell skin structure of .040 R-301W with a cutout at the rear top portion beneath the fin. Each half of the clamshell has a single longitudinal and single diagonal Z-section stiffener, two vertical angle stiffeners for the stabilizer support, and a channel section for stiffening the edge of the cutout and to absorb drag loads from the stabilizer. All of these members are attached to the skin by automatic riveting. The clamshells are assembled with a riveted lap joint at the forward top and on all of the bottom, and at the rear they are attached to the rib shaped closure bulkhead.

A transverse angle across the top of the cutout serves as a fitting for attachment of front spars of stabilizers and fin. Approximately 15 in. back of this angle member is a deep channel for attachment of rear spars of the stabilizers. Fin rear spar attaches to the closure bulkhead at rear of stern.

A series of tubes, one leading from each watertight compartment in the hull, are grouped in the cockpit under the rear seat, for attachment to a bilge pump, and numerous handholes are provided for inspection and servicing.

Seabee main landing gear strut. New production version of this unit has simple elbow fitting for attachment to hull shaft



Comparison of key factors in the construction of the conventional and simplified hulls is given below:

	Conventional	Simplified
Parts	362	63
Man-Hours	590	20
Rivets	6,500	2,400
Weight (lb.)	318	208

Cabin Details

Cabin lines have been established by analytic geometry. Mathematical fairing not only greatly reduced tedious lofting, but made possible the rapid and precise manufacture and inspection of jigs, tools, and dies.

Cabin consists essentially of two main sections: (1) Rear primary structure, tying the wing and engine installation to the hull; and (2) forward section superstructure, enclosing the cabin proper.

Rear primary structure forward bulkhead—consisting of two beaded pressed sections, .040 upper and .025 lower, with a center cutout for access to the baggage compartment—supports the wing front spars and is reinforced by .064 hat-section uprights at each side. Lower end of each upright is riveted to an external fitting which connects the wing brace strut to the hull. Upper ends of the uprights connect to an inverted hat section extension which serves as a crosstie between front spars of the wing panels and also supports the front end of the engine mount. Similarly, over the main step bulkhead there are two other upright hat-sections which attach to another inverted transverse hat-section connecting the rear spars of the wing panels and also supporting the rear end of the engine mount. Top of rear primary section is an aluminum coated .019 low carbon steel firewall.

Side skin of the rear primary structure—.040 R-301W stiffened by secondary vertical channels—is comprised of two sections connected along the mating flanges at the trailing end of the cabin structure.

Forward superstructure—cabin enclosure—includes an .091 61SW crown bow member, five door frame uprights, and .040 61SW skins.

Crown bow member is a rolled combination angle-and-Z-section unit. Door frame uprights are identical to crown bow frame but for attachment to latter have gusset portion at the top. Nesting of crown bow and door frame provides effective surfaces for door sealing. The two side doors and the bow doors are .032 61SW large single-piece pressings spotwelded to an .025 outer skin.

Cabin skin picks up the rivets joining the deck to the hull sides, and is also joined to the crown bow and door frames

largely by automatic riveting process.

Crown skin is on .040 beaded pressing attached to the crown bow member with the same rivets which fasten the side skins

Interior trim and upholstery is of Koroseal—waterproof, flameproof, vermin- and mildew-proof — economically utilized in various weights according to degree of service anticipated. Sponge rubber windcord, having a prefabricated edge to simplify attachment, is used for weatherstripping, color matches the interior, and eliminates necessity of stitching on a separate fabric covering for trimming

Cabin soundproofing is accomplished by using Fiberglas or similar material.

Retention of each the seven large double-curvature Lucite (Heath) cabin windows is accomplished with a uniquely simple Goodrich rubber S-extrusion, one loop being cemented to the pane and the other loop cemented to the edge of the cabin cutout margin. In addition to serving as a glass retainer, the extrusion functions as a weather seal, a vibration damper, and a decorative trim

As far as possible, standard automotive type hardware—Cowles door handles, locks (with slight redesign), pull-to handles, and dome light—are used, with careful selection in regard to weight, strength, and cost, which factors also dictated the use of Tinnerman sheet metal screws and nuts

The back of each Reynolds seat is quickly detachable to serve as a life preserver Front seat tracks and adjustment mechanism are American Forging & Socket standard automotive types.

Engine installation with top cowl in open position. All cowling (top, rear side and forward side) is removable to afford overall access to power plant. Contemplated is removal of air baffling (seen at top of engine to right of oil cooler) and its incorporation as integral part of top cowl, thus exposing entire upper part of engine when cowl is lifted

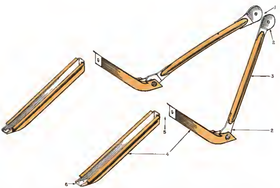
Instrument Panel

Instrument panel is located on left side of cockpit in front of pilot. A package unit in the lower right corner contains Electric Auto-Lite automotive-type engine instruments—oil temperature gage, oil pressure gage, fuel quantity gage, fuel pressure gage, tachometer, and ammeter. By removing four nuts which hold four clamps in the rear of the package, the latter may be removed into the cockpit

Two way Hallicrafters radio is adjacent to left of engine panel package, and by removal of four screws on underside of support shelf forward of panel, and disconnection of power supply, antenna, and phone plugs, the radio may also be drawn into the cockpit. Microphone is spring clipped on the instrument panel and the cord passes through the panel, drawn in from behind by spring tension. Optional radio, with broadcast band and loop antenna provisions, fits the standard installation brackets without any alteration.

Flight panel package contains an airspeed indicator, magnetic compass, altimeter, and ball-bank indicator. The package is drawn into the cockpit by removal of false front by prying, then removing eight screws on the face of the panel. Optional flight panel is equipped with sensitive altimeter, bank and turn indicator, clock with sweep-second hand, and the standard equipment airspeed indicator and magnetic compass

The instrument panel also carries the following control switches: Cole-Hersee master switch, and Douglas or Cole-Her-



Simple and sturdy mount for Seabee's 215-hp. Franklin engine. (1) Position of rubber shock mount at rear (propeller end) of engine, (2) welded fitting, (3) supporting tube, (4) supporting hat-section, (5) position of forward rubber shock mount (on crankcase), and (6) forward attachment point to firewall and wing crosstie. Mount components are interchangeable for use on either side of engine

see domelight, instrument light, anchor light, and running light switches. The Pollak or Bendix ignition switch is designed to control the starter by pressing the key in "Both" position. Key for ignition switch also operates cabin door locks

Other panel controls are pulls for parking brake, carburetor heat, carburetor mixture, and throttle. Signal lights for landing gear position are also installed.

Right half of cockpit panel is omitted to provide free passage to the bow door.

Production installation time for all electric wiring on the craft is approximately 11 min. Wires are furnished in prefabricated terminaled lengths. Spring terminal sockets on switches are used to afford push-pull connections, and knife disconnects are used where wing and tail wires join the cockpit connections.

Landing Gear

Main landing gear utilizes Electrol air-oil struts designed to have a relatively low static air pressure to facilitate servicing. Each strut is fully cantilevered from the hull side and through a bolted elbow connects with a shaft extending through the hull to the opposite gear. Hull shaft is in two sections joined at the hull centerline by a welded sleeve. Channel members at each end of the sleeve provide support by extending to the frame at the hull bottom

Strut torque arms (scissors) are utilized as step means to the cabin, and top torque arm is designed to receive a towing hook.

Retraction and lowering of the main landing gear (equipped with Goodrich wheels and brakes) is accomplished by hydraulic power from an Electrol hand pump located between cabin front seats. Reservoir, thermal expansion valve, and selector valve (flaps are also operated hydraulically) are integral with the hand pump. A bellcrank on the center sleeve connecting the two sections of the hull shaft attaches to the upper arm of a two-arm toggle linkage; lower arm of linkage is attached to a pivot fitting on the hull structure and above this pivot point is also connected the piston of the hydraulic cylinder. Latter is in turn pivoted on a horn attached to the center sleeve. Extension of the piston breaks the toggle linkage from a past-dead-center positive-lock position and rotates the hull shaft to retract the gear. At full-up position of the gear, the linkage again comes together just past dead center to form a positive lock through contact of positioning stops at the break point

Tail wheel is full swiveling and is locked in the fore-and-aft position by a spring-loaded pin with cable connection to cockpit. The wheel is mechanically raised via a cable connection to the main gear hull shaft. Cable action pulls a lock-pin and then rotates a horizontal shaft on which is pivoted the

lower arm of a two-arm yoke on the vertical tail wheel strut The shaft rotates approximately 132 deg to place the wheel alongside the boom

In addition to its function to retract the tail wheel, the horizontal shaft is ingeniously designed to serve as a shock absorber for tail wheel ground loads It is hollow and surrounds a piston attached to the upper arm of the two-arm tail wheel yoke In the space between the piston circumference and the interior circumference of the horizontal shaft is a layer of rubber secured to the piston and shaft interior surface Upon application of ground load to the tail wheel, the piston is displaced inwardly and the surrounding rubber acts in shear to absorb the forces imposed

Alteration of the tail wheel design is contemplated, to render the unit steerable as well as swivable

Engine Installation

Power plant is a 6-cyl, aircooled, wet sump Franklin engine, mounted as a pusher, located above and aft of cabin, directly over the firewall decking the baggage compartment Mounting is essentially a three point support Propeller end of power plant is carried by two converging steel tubes with slotted ends welded to heavy attachment plates for bolting to an engine pedestal carrying a rubber shock mount. Attachment plates at bases of supporting tubes are bolted to 049 pressed steel hat-sections, in turn bolted to the firewall Each of these hat-sections runs forward and up in a longitudinal plane parallel to the engine thrust line and is picked up by a bolt in another shock mount pedestal on the crankcase From this pedestal another hat-section on each side runs forward and down and is bolted to the firewall Components of the mount are interchangeable for use on either side of engine

Ground adjustable Aeromatic propeller (standard equipment) has laminated maple blades chemically sealed in the ferrule Blade covering is black Aeroloid plastic sheeting, and Monel metal sheathing over the plastic protects the leading edge Optional Hartzell reversible pitch propeller is pitch changed by engine oil pressure with manual operation of valve control in cockpit

Power plant accessories include Electric Auto-Lite starter, generator, regulator, and distributor

Cowling

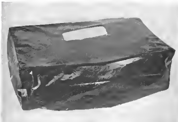
To eliminate fillets and compound curvature of the rear lower cowling, it has been constructed in two sections of simple wrapped sheets Each section is straight at the sides and meets the wing at 90 deg Rear of each section wraps around to meet the other section at the centerline of the craft, and attachment to cabin sides is by quick fasteners Forward lower cowling on each side is a straight section, also attached by quick-fasteners

Top cowling, from propeller end forward to engine fan housing, is a single wrap around sheet pivoted at forward end similar to an automobile hood and is held in the open position by a brace rod on each side In closed position, top cowling is fastened with quick-latches to lower cowling Forward of the top cowling is another top section fixed in place

With top cowling up, and with rear side cowling removed, entire engine accessory section is accessible for servicing Then, by detaching the top cowling by removal of a few bolts and then unfastening forward side cowling, the entire engine installation is accessible

Fuel cell is a Goodrich bladder type bag, made of rubber-impregnated fabric, located inside the hull just forward of the main step and between two watertight bulkheads The unit rests on a plastic sheet over the hull bottom stiffeners, and is fastened to the deck structure by snap fasteners which have sufficient play to facilitate adjustment in securing the bag to the male fastener components on the structure

Top of the bag is provided with an opening approximately 5½ by 12 in over which a metal cover plate carrying the filler neck and fuel level gage is installed by bolting to the bag and also to the deck skin, which has a corresponding cutout for removal of the fuel cell. A drain at the bottom of the cell connects to a pipe which runs behind the main step where it is fitted with a drain plug



Fuel cell—rubber impregnated bladder type unit—has cutout for attachment of plate carrying filler neck and fuel level gage.

Acknowledgment The editors of AVIATION are grateful for the cooperation of the management and engineering departments of Republic Aviation Corp, Farmingdale, N Y Particularly credited is A. Z, Boyajian, structures project engineer, Seabee Div. Others who generously cooperated are H. Lasker, plant manager, V. H. Springford, superintendent of production, and engineers G Hildebrand, body; R F Yee, power plant; C. S Aldrich, landing gear, and J E Glover, Jr, equipment.

V-2's Power Plant Provides Key to Future Rocketry

By ROY HEALY, *American Rocket Society*

The path has been opened to a new era in flight by development of an engine capable of propelling craft at tremendous speeds and to hitherto unattainable altitudes. And far-reaching developments are indicated if vigorous rocket research is pursued.

PREVIOUS BARRIER to successful flight through the upper atmosphere and beyond has been lack of a rocket power plant of sufficient power, economy, and reliability While the propulsive unit of the German V-2 was far from the optimum in the latter two respects, its power and excellent prospects have proved of particular interest

The engine burns a combination of ethyl-alcohol and liquid oxygen. Propellants are forced into the combustion chamber by turbine-driven pumps powered by superheated steam resulting from rapid decomposition of hydrogen peroxide under catalytic action.

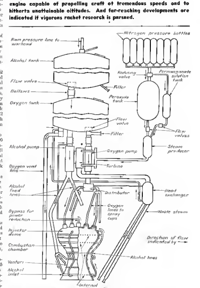
V 2's total length is 45.8 ft, with 20½ ft occupied by two tandem-positioned aluminum alloy tanks Of cylindrical section and with domed ends, each has about 154 cu ft. volume The upper tank, containing the alcohol, tapers slightly toward the nose of the rocket to conform to its contour With fittings, this tank weighs 255 lb and, for the average V-2 flight range of 155 mi., was filled with 8,400 lb of 75% ethyl-alcohol solution in water

Lower tank with fittings weighs 375 lb and contains a normal supply of 10,620 lb of liquid oxygen Both tanks are insulated from the V-2's outer steel shell by heavy layers of glass wool The wool also was to aid in rapid establishment of thermal equilibrium between the tank and liquid oxygen during filling

Flow control valves are situated in the main 6-in dia outlets of each tank Between valves and pumps are 6-in dia brass bellows connections to allow for differential expansions between the various components. Large inspection plates are installed in the upper dome of each tank, while filler openings are provided at the bottom

The alcohol solution is conducted to its pump by means of a double-walled glass-wool insulated tube which passes through the length of the oxygen tank Both tanks are supported between two circular steel frames of angular section, one at each end of the tank bay

Prior to filling, the tanks are subjected to a leakage test pressure of 26 5 psi. During the burning period a pressure of about 20 psi absolute is maintained within each tank, partially to prevent collapse as the propellants are exhausted and also to aid the turbine in pumping the fluids to the engine During initial stages of burning, an aperture



Schematic diagram of V-2's power plant plots sequence flow of fluids. Fuel ratio amounts to 153 lb./sec. of oxygen to 123 lb. of alcohol water solution. (Sketch by author.)

in the rocket's nose supplies air ram pressure on the alcohol, then as lower air density is encountered in ascension, this line shuts off and pressure is supplied from nitrogen cylinders in the instrument compartment. Pressure on the oxygen tank is maintained by vaporizing a small quantity of the liquid oxygen, then returning it to the tank.

Approximately 285 lb of hydrogen peroxide (80% concentrate) are contained in a 25-gal ovoid tank. Fabricated of low manganese steel sheet, this tank is located to one side of the centralized turbine-pump assembly. In close proximity is a 2-gal tank usually filled with 35 lb. of potassium permanganate in saturated aqueous solution (both sodium and calcium permanganates have also been used).

Eight high-pressure nitrogen bottles are cradled in a framework in the accessory section. Containing approximately 30 lb. of nitrogen gas, they are used to operate valves in the power section. Flow of high-pressure nitrogen to these valves is in turn controlled electrically from the instrument compartment.

Launching Preparations

Preparatory to fueling, the V-2 is raised to a vertical position (it rests on heavy steel pads at the bottom of each fin). Fluids are pumped into the rocket tanks in the following order: Alcohol, peroxide, oxygen, and permanganate. Loss of liquid oxygen in chilling its tank down to thermal equilibrium at —183 deg. C. is considerable and requires use of a large vent valve in the tank to prevent excessive pressure build up due to evaporation. It is estimated that even with the tank chilled, some 4.5 lb. of oxygen boil off per minute.

Ignition method utilizes two Roman candles, of 10 sec. duration, inserted into the combustion chamber on opposite ends of a centrally pivoted arm. Electrically ignited, this resultant pinwheel whirls around in a horizontal plane spouting flame and sparks within the chamber. Main tank valves are opened (electrically from the ground station), and the gravity head on the propellants carries some 25 lb./sec. of the fluids around the pump rotors and down into the chamber. Upon proper combustion of this initial flow—with generation of about 17,000 lb. thrust—an impulse is sent into the turbine flow control valves. Within less than a second the turbine is operating at rated speed and the pumped-in propellants are developing about 58,000 lb. takeoff thrust. Total ground burning time, on successful launchings, lasted 3 sec. from pyrotechnic ignition to takeoff.

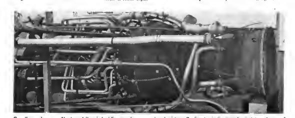
Size of Nazi V-2 bomb and power plant at recent AAF exhibit is clearly shown in this photo. Author Healy is at left in group in front of rocket engine.

Rocket Engine

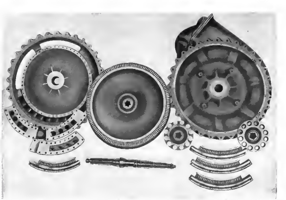
Power bay takes up a space of 12.4 ft. The lower 6 ft. of this section is occupied by the engine, composed of a dome-shaped injector head, containing 18 propellant inlet spray cups, welded to an integral combustion chamber and convergent-divergent nozzle assembly.

Dome, chamber, and nozzle assembly are fabricated of low carbon steel comparable to SAE 1020. The jacket is of the same material and is welded to the engine. With spray cups installed, the engine weighs 1,025 lb., while total weight of the unit inclusive of accessories, valves, and feed lines is 1,975 lb.

Maximum internal diameter of the combustion chamber is 37.3 in., while the nozzle has a 15.7 in. throat and a mouth of 29.2-in. dia. Average chamber pressure during operation runs about 220 psi. absolute, while nozzle design is such



Overall view of engine. At extreme left, main feed lines may be seen entering bellows connections to pumps. At top are numerous small oxygen distributing lines. Bifurcated alcohol line (top and bottom) branches into smaller lines terminating in cooling jacket annulus around engine nozzle. Large tube in upper foreground is oxygen vent, while nozzled line above it and to right is a steam vent.



Turbine disassembled. Aluminum alloy rotor is at center with drive shaft beneath. At left is inlet section with (below) steam distributors and one section of nozzles. Other nozzle sections are at lower right, and above these are exhaust side of turbine and bearing supports.

that final expansion of the jet is slightly below one atmosphere at sea level.

Within chamber and nozzle are four rings of alcohol spray orifices, connected to the main alcohol inlet by the cooling jacket and external connecting lines. These orifice rings provide a cooling film of alcohol on the inner wall of the chamber and nozzle to reduce heat transfer from the burning gases to the steel. Apparently the combination of external with internal cooling is largely successful—for combustion temperatures exceed 2,650 deg. C., while the walls do not appear to have attained much over 1,000 deg. C.

The top row of alcohol spray holes, positioned at a point where the chamber interior diameter is 36.2 in., consists of 176 jets of .090 in. dia. The next row beneath is at 29.75-in. chamber dia. and contains 150 orifices of .106-in. dia. Just above the nozzle throat (at 15.7-in. dia.) is the third row containing 90 holes of .106-in. size. The lowermost ring, about 10 in. above the nozzle mouth, consists of 140 holes of .106 in. dia.

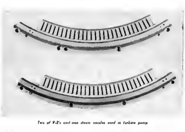
Lower portion of the nozzle, below the cooling jacket, is surrounded with glass wool insulation to prevent its heat from being transmitted to the tail shell. With an oxygen-alcohol consumption of 276 lb./sec., a sea level thrust of about 58,000 lb. is normally developed. This figure rises to some 64,000 lb. near the end of burning when reduced atmospheric pressure, and higher accelerations on the fluids, increases the engine's power. Operating time is usually 63 sec., of which 60 are flight time. Balance of the fuels either are consumed on the ground before takeoff or remain in the tanks after power cut off when desired velocity has been attained.

Aluminum alloy rotor for V-2's turbine pump, showing fitting for shaft in center

Injectors

Set into the injector dome in two concentric circles are 18 double-walled spray cups. Each are about 6 in. in dia. at their external base. The cups are mounted so that the spray from their open ends in the chamber converge upon the engine's centerline. Into the top of each cup is screwed a brass oxygen spray nozzle, not unlike the head of a salt cellar, containing 7 orifices which serve to vaporize the liquid oxygen. From 18 separate lines, emanating from a distributor valve in the accessory section, the oxygen is forced through the nozzles under approximately 300 psi. pressure.

Alcohol feeds into the annular space between inner and outer walls of the spray cups to spray through 5 rows of small orifices (totaling 64 in number) to intermingle with the cross-sprays from the oxygen nozzle. The thoroughly mixed propellants are forced out into the combustion chamber for burning. Less than 10% of the alcohol fed into the engine



Two of V-2's cast iron steam nozzles used in turbine pump

is injected through the 556 wall cooling inlets below the injector dome.

Alcohol feeds from the pump through 6 branch tubes into an annular ring surrounding the nozzle near the lower end. From this ring the fuel passes into the nozzle through the bottom row of coolant holes, then upward through the concentric cooling jacket, next upward externally through four lines, which feed into three other annular rings around the engine and then terminate at inlets into the injector dome jacket. To allow for engine expansion during burning, connecting lines are looped and four expansion rings are spaced between the annular fuel-feed rings.

In the center of the injector dome is an alcohol return valve which allows feed back of some fuel from the dome cooling jacket directly to the inlet side of the alcohol pump, thus effectively reducing the rate of injection into the combustion chamber. When the V-2 nears the desired flight speed for the selected range this valve opens and power output is reduced to approximately one-third of normal, and then is gradually reduced to zero by shutting down of the turbine system. This bypass valve is actuated by nitrogen pressure upon electrical impulse either from the ground or upon signal from an integrating accelerometer in the instrument compartment.

Engine thrust is transmitted to the main circular frame, between the tank and power bays, through four $2\frac{1}{4}$-in. steel tubes which act as the engine mount. Crossbraces between these tubes, and fittings welded to them, serve to support accessories, accessory tanks, valves, and feed lines. The engine mount, exclusive of the circular framework, weighs 260 lb.

Controlled mixing of concentrated hydrogen peroxide with the permanganate solution is achieved in a steel steam producer of approximately 9-in. length by 8-in. dia. with hemispherical ends. Completion of an electrical circuit introduces pressure from the nitrogen bottles upon each of the tanks. A further electrical impulse opens two solenoid valves allowing the peroxide and permanganate to flow into the steam producer. The violent breakdown of the unstable peroxide when exposed to the catalyst produces large quantities of super heated steam and gaseous oxygen. The temperatures developed in the reaction range around 275 deg. C. The resultants of the reaction are conveyed, through an asbestos lagged steel line, to a distributor ring near the turbine and from it through two branch lines to the turbine nozzles.

Turbine

The single-stage steam turbine, with its single rotor containing two rows of blades, is in itself a remarkable piece of power producing equipment. The outer casing of steel has a 24-in. dia., while the mean diameter of the rotor is 16.5 in. Rotor blades, and stator are aluminum alloy. With an inlet flow of 5.4 lb./sec. through the two rows of cast iron nozzles, at an estimated 360 psi. pressure, the turbine generates some 500 hp. at a normal operating speed of 3,850 rpm. Should the turbine overspeed (5,000 rpm or more) because of lightened loads, an automatic cutout shuts off the peroxide-permanganate flow to the steam producer. This precaution is taken to prevent throwing of turbine blades and wrecking of the rocket.

Waste Steam

After leaving the turbine outlet, waste steam and other contained chemicals are led through a heat exchanging unit. Main purpose of this device is to vaporize a small amount of liquid oxygen, bypassed from the oxygen distributor valve, which is then returned to the oxygen tank to maintain its desired internal pressure. The quantity of oxygen flowing through the vaporizer coils about the steam line is controlled to maintain constant oxygen tank pressure. A secondary effect of this heat exchange is reduction of back pressure in the steam line, thus aiding turbine operation.

After leaving the vaporizer, waste steam is conducted through two 4.5 in dual tubes and exhausted out the tail of the rocket through two louvers in the shell near the rocket nozzle mouth.

An interesting point is that the turbine rotor is located on the rocket's longitudinal axis and the gyroscopic effect is used in holding the missile on target.

Pumps

The turbine rotor shaft, extending on each side of the casing, is used to directly drive two centrifugal-type pumps which feed the propellants to engine. These pumps are fabricated of low carbon steel. The impeller of the oxygen pump has a diameter of 10.55 in., and delivers 153 lb./sec. of oxygen to the outlet at a pressure of 380 psi. when rotating at 3,850 rpm. The alcohol rotor, with a 13.45-in. dia., delivers 123 lb./sec. to the outlet at 410 psi. pressure at normal rotational velocity. Pressure losses suffered in the oxygen distributing system reduce oxygen injection pressure to approximately 300 psi., while the alcohol, having travel and line losses, enters the spray cups at a similar figure. When the valves of the tanks are opened at ignition time, the oxygen, having a shorter and more direct course, sprays through its nozzles in the injector caps before the alcohol has filled up the engine cooling jacket and the annular space between the walls of the spray cups. To prevent oxygen from entering the alcohol inlets, at this time, paper sleeves are fitted into the spray cups blanking off the alcohol inlets. When fuel surges through its jets it collapses the sleeves, and they are burned in the subsequent combustion.

Plumbing

What at first glance appears to be a plumber's nightmare of interwoven tubes and pipes evolves, after a bit of study, into a simple arrangement of fluid supply lines. The diagram accompanying this article illustrates the flow sequence.

From the alcohol pump, two 4-in. aluminum alloy lines convey the fuel downward past the joint of the dome and chamber of the engine, there branching into six 2-in. tubes which terminate at equally spaced inlets of the cooling jacket annulus at the engine nozzle.

Four $\frac{7}{8}$-in. steel connecting lines aid in conveying the alcohol upward to the dome, in addition to providing a flow to three smaller annular passages, around the engine, which connect to the wall spray rings. The alcohol bypass line, returning fuel from the power reducing valve in the center of the injector dome, is of $1\frac{3}{4}$-in. dia.

Liquid oxygen is conveyed from its pump through a single 6-in. aluminum line to an electrically controlled distributor valve. From this valve 18 separate $1\frac{3}{8}$-in. lines, in groups of three, are led downward into the spray cup oxygen inlets. Another small line from the distributor leads liquid oxygen to the vaporizer coils around the waste steam line, where evaporation takes place before the oxygen is returned to its tank through a $1\frac{7}{8}$ in. tube.

A 4-in. relief line, with a nitrogen-actuated valve, serves to vent excessive oxygen tank pressure in case of ignition misfire, or if dangerous pressure builds up in flight after the turbine has been shut down. This line vents through the rocket shell at the engine nozzle mouth, in proximity to the two waste steam outlets.

In addition to four steering vanes on the rear ends of each fin, the V-2 is equipped with four equally spaced jet deflectors positioned to the rear of the nozzle mouth. Formed from powdered graphite, sintered with a binder under high pressure in a process developed by the Siemens works, these are machined to desired shape.

Both deflectors in the same plane as the turbine rotor are coupled with the two external vanes in the same plane. The other two deflectors are independently driven, and they may act either together or differentially in "elevon" fashion, and are not connected to the external vanes. The deflectors are actuated by an electric hydraulic system with control of the electric motors by impulses from the instrument compartment. Total weight of deflectors and their driving mechanism is 470 lb.

Power Control

In earlier models of the V-2 flight control of the power unit was exercised from a Kommandogeraet (control) station at the launching site. Automatic analysis of data telemetered from the rocket gave the ground control group a continuous picture of the missile's altitude, velocity, and angle relative to the ground. When the desired combination of these factors had been attained to guarantee the predetermined range, a signal was directed to the rocket which resulted in opening the alcohol return valve to reduce thrust, this action being followed in a few seconds by engine stoppage. Later models were self-controlled, being equipped with an integrating accelerometer fitted with electrical contacts to actuate all controls.

Dividing the jet velocity (6,725 fps.) by 1G gives a specific impulse of 210. Multiplying mass rate of discharge (276 lb./sec.) by this specific impulse results in 57,960 lb. takeoff thrust, which agrees very closely with the projectile's known performance. However, dividing the above thrust figure by the total weight of fluids used, including the turbine flow, results in a specific propellent consumption of 205 lb./thrust/sec./1 lb./propellant/sec.

The V-2 operates at a jet utilization efficiency of approximately 80% when its peak powered velocity of 5,200 fps. is attained. An average thrust of 60,000 lb. for 60 sec. gives a total impulse of 3,600,000 lb./sec. for the V-2. This indicates a thrust of 128 lb./sec. available for each lb. of takeoff weight. Contrasted to this figure is the 20-30 lb./sec./impulse normally used for each 1 lb. of launching weight of solid-fuel rocket projectiles. Such short-range missiles are designed with from 12% to 18% of their launching weight in the form of propellant. But in the V-2, propellants comprise almost 70% of the weapon's takeoff weight.

Machined jet deflectors of sintered graphite are bolted onto their pivots at rear of nozzle mouth. They give missile directional control when flight conditions render air vanes ineffective

V-2 Weights for 250 Kilometer Flight

Warhead	
Nose and shell	410 lb
HE charge	1,748 lb
	2,150 lb
Instrument Compartment	
Structure	328 lb
Radio equipment	155 lb
Electrical equipment	316 lb
Nitrogen supply	80 lb
	875 lb
Tank Bay	
Shell and glass wool	1,250 lb
Oxygen tank	375 lb
Alcohol tank	255 lb
	1,880 lb
Engine Bay	
Shell around engine	410 lb
Engine mount	260 lb
Auxiliary units	880 lb
Lines, valves etc.	70 lb
Rocket engine	1,025 lb
	2,645 lb
Flight Controls	
External fins	750 lb
Jet deflectors and drive	470 lb
External vanes and drive	115 lb
	1,333 lb
Weight empty	8 63, lb
Propellants	19,340 lb
Takeoff weight	28,020 lb

Note: Considerable variations in weights of components and propellants were found in the various V-2s which were examined.

Holding that compressed air for overall actuation of aircraft auxiliary systems affords distinct advantages, the author offers a graphic study of a suggested air-operated installation. Moreover, he gives pertinent comparisons with hydraulic and electrical forms of motivation as he presents his—

Case For The Full-Pneumatic System

By **JAMES L. DOOLEY**, *Project Engineer, Harvey Machine Co.*

THERE HAS BEEN CONSIDERABLE recent interest in the application of compressed air as a subservient power medium in aircraft, for in many instances pneumatic operation is desirable for functions which are now accomplished hydraulically or mechanically.

Because compressed air for ancillary power in aircraft has not been used extensively in this country, data on actual applications of complete pneumatic systems are rather meager. There have been several specialized applications of compressed air—for engine starters, gun chargers, and emergency braking and landing gear systems—but in this general review of pneumatic systems for aircraft, we shall treat these specializations only as part of the complete system.

Considered as a complete system, compressed air power has many advantages over either hydraulic or electric power. These include:

1 Saving in overall system weight.
2 Saving in initial cost
3 Greater safety factor
   a. More available stored energy
   a. No hazard from sparks or oil
   c Inexhaustible fluid supply
   d. No danger of shock.
   e. No critical synchronization problem
4 Easier servicing
   a. Simpler understanding for average mechanic.
   b Fewer close-tolerance fits
   c. Fewer lines—no return lines.
   d No bleeding, filling, or messy leaks.
5 Better adaptation for some functions
   a Faster operation at high peak loads
   b Utilization of compressibility of actuating air
6 Use of air for its oxygen content, buoyancy, or cooling properties

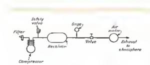


Fig 1 Diagrammatic layout of basic open system

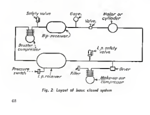


Fig. 2 Layout of basic closed system

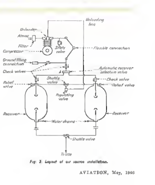


Fig 3 Layout of air source installation.

Briefly, any pneumatic power transmission system consists of a compressor or air pump, receiver or pressure vessel to store pneumatic energy, valving, and means of utilizing the compressed air for actuation. The latter may be an air motor or a cylinder and piston, in any of their many forms

In an open type system (Fig 1), air is drawn into the compressor from the atmosphere and exhausted from the motor, turbine, or cylinder. In contrast to this, the closed type system (shown in Fig 2) returns the exhaust air to the compressor intake. Make-up air for the system is supplied by a separate compressor or by special valving systems. The closed system has the disadvantage of requiring large low-pressure return lines and a large capacity low-pressure receiver, making it complicated and heavy. Since the simple open system appears to be better suited for aircraft, this discussion will be limited to that type of installation

Basic System

To the simple open system (shown in Fig 1.) we must add filters, compressor regulation, and moisture removing equipment as well as ground charging connections, safety valves, drain valves, and check valves—making our air supply and storage system appear as seen in Fig 3. Note that here we have duplicate receivers for vulnerability considerations, also check valves to prevent complete loss of air should a line or receiver be damaged. The emergency receiver selection valve automatically diverts compressor discharge to the remaining good receiver when one unit is punctured or pressure is lost abnormally in any way. Duplicate lines may be run up to the point of use and a shuttle valve installed, so that either line can supply operating air (This would not be done in small planes.)

In any open system, all air taken into the compressor comes from ambient atmosphere, hence always contains some water vapor, and perhaps some liquid or solid water particles, although the latter are easily eliminated. When the air is compressed and cooled, the water will partially condense out (in accordance with the Law of Partial Pressures) and may collect as a liquid or solid. Unless there are proper precautions water may collect in critical places and freeze when low temperatures are encountered, causing malfunctioning. However, with proper design, practically all water can be condensed out and retained in the air receivers or separators, to be removed at will. The small quantity of water remaining in the air will do no harm. To remove excess water, several precautions must be followed—

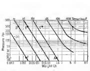


Fig 4 Chart showing weight of water as vapor in 10 lb of dry air

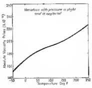


Fig 5 Values of air viscosity plotted against temperature

1 All air from compressor must go through receivers

2. Water must not be allowed to freeze before entering receivers. Air line should be insulated or a small receiver installed as a trap at proper location.

3. Receivers must be located in *coldest* ventilated place in plane

4 Receivers must be connected into system so that liquid water is not drawn into exit

Within the limits of the Law of Partial Pressures, the amount of water existing in the air, as vapor, at any pressure and temperature can be calculated (as shown graphically in Fig 4). At higher pressures, the equations do not accurately apply because of the supercompressibility phenomenon. In many instances the air becomes reheated after it has dropped out most of the water at the receiver. This reheated air tends to dry out the system—by evaporating the small amount of dew on the inner walls and carrying it to exhaust

To illustrate what happens to the water, let us study several conditions in conjunction with Fig 4. Note that the chart and all the values used here are based on 10 lb of dry air—approximately that required in a fully charged medium-sized system

Case 1. Consider a system charged on the ground on a hot damp day. Assume that saturated air at 100 deg F is used as the medium for process of charging

(1) At intake point (A), the 10 lb. of air holds 0 44 lb of water, as vapor

(2) Assume compressor discharge to be at 400 deg F and 500 psi—point (B)—so that at discharge same air could hold 6 4 lb. of water, as vapor, but still has only 0 44 lb, making relative humidity 6 9%. Hence, air would pick up any moisture in discharge line

(3) As this air in receiver cools to, say, 120 deg. F—point (C)—which is 20 deg above ambient, it can hold only 0 02 lb of water, as vapor, so that 0 42 lb. must have condensed out in receiver and possibly in some lines. This is liquid or solid (mist or snow) and can be collected in receivers or separators

(4) If air in (3) further cools down to 10 deg F—point (D)—at which it can hold only 0 0004 lb of water vapor, practically all of water has condensed out so that although lower temperatures may be encountered because of high altitude or expansion of air, insufficient water is present to cause trouble

Case 2. After having flown for some time in low temperatures, say 10 deg F or lower, when all water in system has become frozen in receivers or has formed a frost coating in lines, consider that higher temperatures are encountered, say 50 deg F. Compressed air in system then reheats to point (E) at which it can hold 0 0023 lb of water vapor. Hence it has a relative humidity of only 17 4, and will have a tendency to pick up water by evaporation (and ice by sublimation) and dry out system. At higher temperatures drying effect is even greater

Case 3. When ground temperatures are very cold, say -30 deg F, there is very little water vapor (0 0017 lb. in 130 cu ft.) in air at intake—point (F)—and even then, most of this is frozen out in receivers, hence air in lines is dry for all practical purposes

Case 4. Consider that after plane has been at altitude and system is extremely cold, it descends to low altitude where air is warm and moist. Water will then condense and/or frost will form on outside of receiver and lines, tending to warm inside air. If system pressure is down and compressor operates, charging cold system with warm moist air, cold tubing and receivers would cool air, condensing out some water and warming system. Very little water vapor should get past receivers

Case 5. If a 5-cfm (intake capacity) compressor were running continuously under extreme conditions of *Case 1,* it would take 8¾ hr to collect 1 gal (231 cu in or 8.5 lb) of condensate in receivers. Small remainder of total water intake in that time would have been blown through system and exhausted, or still exist as vapor in system

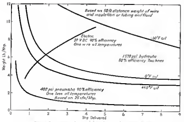


Fig. 6. Comparison of transmission of power for various lines.

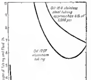


Fig. 7. Weight of tubing and fluid required to transmit 10 bhp through 50 ft. of line at 97% efficiency (Only commercial sizes used)

Case 6. On an average day (70 deg F, 50% r h), water intake for a 5 cfm compressor, as in *Case 5*, operating for 8¾ hr. at sea level would be only 1 5 lb At altitude and lower temperatures, amount would be even less

The foregoing analysis indicates that it is unnecessary to install chemical drying agents in the system They are difficult to maintain, heavy, costly to install, and will remove only slightly more moisture than specified above

Since almost all the oil from the compressor is removed from the air along with the water, any equipment using this air must contain its own oiling system or be capable of non-lubricated operation

In an aircraft pneumatic system where many devices use the compressed air without expansion, the pressure at which the air is employed is theoretically immaterial, that is, a constant weight of air will be required for a given operation However, from the practical and commercial aspects, air pressure variations are of considerable importance The following factors all influence the pressure selection:

1 In pressure range from 300 to 3,000 psi. there is very little reduction in required capacity of compressor for an increase in discharge pressure for any given system, because most of air is used on a "square card" (no expansion) basis This means that overall efficiency decreases at higher operating pressure

2 Air compressor becomes more complicated, heavier, and costlier if pressures are selected that require three stages of compression. Second intercooler and third stage cylinder add considerably to compressor troubles. Third stage cylinder is so small on aircraft type compressors that high pressure valves and piston rings are almost watch-part size and are not efficient. Maximum pressure to which one can go with practical success in a two-stage aircraft compressor is about 1,000 psi Intermittent-duty slow-speed two-stage machines for sea level operation only are used for pressures up to 1,500 psi, but an aircraft type compressor must deliver air continuously at high speed even when inlet pressure is low (at altitude)

3 Slightly better water elimination can be had at higher pressures at any given temperature (Fig 4).

4 System pressure should be below that at which receiver shattering occurs when hit by a projectile

5 Pressure should be high enough to get efficient transmission in lines no larger than present hydraulic lines A value of 300 psi or more, will accomplish this (See Figs. 5, 6, and 7.)

6. For operation of air cylinders it is desirable to use high pressures to keep diameter down. However, higher air pressures do not always make for lighter cylinders Combined air-and-metal weight is almost constant for a cylinder, to handle a given set of conditions (force and stroke), regardless of pressure employed, provided same design factors are used And this applies only in range under discussion here (300 to 3,000 psi.)

7. It is desirable to use pressures for which there is aircraft pneumatic equipment available

8. At higher pressures, small size regulators and control valves are more difficult to keep tight This has been proven by existing systems wherein almost all difficulties occur in or ahead of pressure reducing valves.

These factors indicate that the system operating pressure should be under 1,500 psi, and some equipment is available for these pressures Lower pressures can be had by installing a reducing valve, and higher pressures, in small quantities, can be had by using a pneumatic displacement booster.

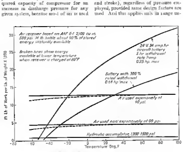
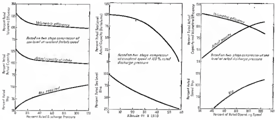


Fig. 8. Comparison of energy storage systems



Figs. 9, 10 and 11. Graphs of typical compressor performance characteristics

Air Compressors

The heart of the pneumatic system is the air compressor. One of the reasons pneumatic systems did not receive more consideration in the past by aircraft men was that no practical compressors were available. This equipment is available now, but because of inherent limitations, no design can attain the high output per unit weight of the hydraulic pump For example, to deliver 1 cfm of hydraulic fluid at 1,000 psi, a pump must handle only 0 134 cfm of liquid at the intake, whereas a 1,000-psi. compressor delivering the same volume of compressed air must handle about 9 0 cfm of sea level air at the intake and even more at altitude. This means that if the same volume output is wanted, the intake side of the compressor must be physically larger than the hydraulic pump, hence much heavier

However, because pneumatic energy can be stored at very little expense in weight (Fig 8), the high peak loads in the system are not supplied with air directly from the compressor but from the compressed air stored in the receivers Hence, it is unnecessary to have compressor output equal to the pump output in an equivalent hydraulic system In most aircraft pneumatic systems the time required to initially charge and to refill the receivers usually determines the minimum compressor capacity, but not the peak load requirements In many cases the compressor is not running when the peak loads are handled In spite of this reduction in output, the compressor usually weighs more than the pump in an equivalent hydraulic system, but this weight penalty is more than offset by weight savings in the remainder of the system Typical compressor performance characteristics are shown in Figs 9, 10, and 11

Four basic types of drives for the compressor have been considered for aircraft service

1 Electric motor with gearing

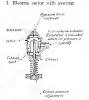


Fig. 12. Details of compressor unloading valve.

2 Self contained engine-compressor unit

3 Power takeoff from main engine

4. Auxiliary engine

Although there are several makes of small (less than ½ cfm intake capacity) multi stage electric-motor driven air compressors on the market, which are quite successful, it does not appear practical, at the time of this writing, to build motor driven machines of much larger capacity (over 1 cfm intake), because of the following factors

1 Any motor driven aircraft compressor must be capable of starting at —65 deg F, and since oil lubrication is required, severe breakaway torques are encountered, calling for more motor than is normally necessary

2. Since considerable power is required, the high current loads cannot be handled by batteries hence either main or auxiliary engines must be running to supply current This is not necessarily true with very small compressors

3. Weight of the 28-v d c. electric motor, switches, line, and generator is almost triple that of compressor proper A high frequency a c. power system is somewhat lighter than low voltage d c. but is no cheaper, and foregoing difficulties still apply

4 Because an electric-motor-driven compressor is an independent unit, it must have its own lubrication system, air cooling system, and unloading system for starting These make for increased weight, complication, and cost, and are not required on an engine driven unit

A small self-contained engine-compressor unit that starts and stops automatically to maintain receiver pressure, would seem to have interesting possibilities, but to the writer's knowledge noth-

ing has been performed along this line

By mounting the compressor on an engine pad (either main or auxiliary) drive pad, it can be lubricated from the engine system, and cooling air can be provided from the slipstream or by engine cooling air. Low temperature starting is much less severe than with the independent electric-motor-driven compressor because the oil is either diluted with gasoline, or the engine is warmed, or both, and considerably more power is available for breakaway. The engine-driven unit appears to be more reliable, lighter, simpler, and less costly; accordingly we will limit our discussion mainly to this type.

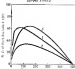


Fig. 13. Plot of energy values available in receiver

When the system pressure reaches a predetermined maximum, it is necessary to stop the flow of compressed air. It is desirable to do this in the simplest way possible and yet have a low unloaded hp requirement, since there are long periods of operation when no air is required. If the compressor is connected directly to the engine, these methods of unloading may be used:

1. Inlet valves may be held open continuously (free air unloading), allowing air to surge in and out of cylinder with each stroke.

2. Intake line may be closed (inlet unloading), allowing cylinders to pull a vacuum in intake manifold

3. Cylinder clearance may be greatly increased by opening one or more "pockets" in cylinder head (clearance control), thus reducing volumetric efficiency to zero.

4. Discharge line may be checked and relieved to atmosphere (discharge line unloading).

5. Sufficient permanent clearance can be built into compressor cylinders so that volumetric efficiency reaches zero at a safe pressure several times operating pressure. This method is simplest but compressor also has low volumetric efficiency at operating pressure where high capacity is desired. Also, this form of unloading does not lend itself well to multi-stage compressors.

These methods require some power in unloaded condition, in turn causing use of gasoline during the long idle periods in flight. Hence it would appear that unloading by stopping the compressor is more desirable. De-clutching has the following advantages:

1 No power is required when unloaded.

2 Less wear on compressor

3. Should compressor fail and lock up, clutch would slip and prevent damage to engine.

Except for the unloading arrangement specified in Item 5 preceding, an outside source of power is required to actuate the unloader or clutch. Since any aircraft compressor must be automatic, this power must be furnished by compressed air from the receivers. The usual type of pressure regulator valve used is shown in Fig. 12. When a predetermined maximum receiver pressure is attained, the valve proper snaps down, applying receiver air to the unloading mechanism. At the pre-selected minimum pressure the valve snaps up, closing off receiver pressure and draining the unloader air to atmosphere, thus loading up the compressor. Note that the inlet seat must be smaller than the exhaust seat and that the collar must be properly fitted to insure snap action. The range is a function of seat areas, of valve travel between the inlet and exhaust seats, and of the spring scale. Inlet seat area and spring force determine the unloading pressure.

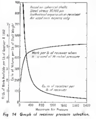


Fig. 14. Graph of receiver pressure selection.

The valve should be located near the receivers for good snap action. These valves may vary in detail but the basic principles are the same, the usual aircraft type weighing about 5 oz.

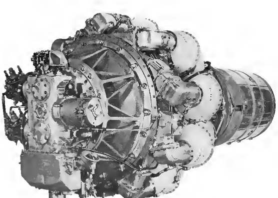
It is unnecessary to describe here the several basic types of air compressors and their many variations, since this information may be found in texts on the subject. But there is no reason to believe that an aircraft type compressor will not be similar to practical high-speed industrial units, for the same capacity and pressure. In other words, it will be the automotive-piston type, with aircooled intercoolers (for cooling the air when multi-staging is used), placing emphasis on valving, weight, and compactness. An analysis indicates that the radial and barrel-type designs best meet weight and space requirements. Since any engine mounted compressor must run at speeds up to 3,600 rpm, inlet and discharge valves must have much larger flow areas than conventional lower speed machines. Also, since the compressor must pump at high altitudes, the pressure drop through the inlet system and valves must be kept low. In some instances the high pressure compressor inlet air can be taken from the turbo charger or from the compressor of the gas turbine.

Energy Storage

As previously implied, lowest overall weight and maximum utility occur when a small capacity air compressor is used, with sufficient pneumatic energy stored in receivers to handle the high peak air requirement. The energy available in any vessel of compressed air at a given pressure is a function of how the air is employed, the pressure at which it is used, and how rapidly it is dissipated. This is shown in Fig. 13, based on the ft-lb. of work available in a standard 2,100-cu in. AAF Type G-1 oxygen bottle under 500 psi air pressure. It is to be observed that maximum energy can be withdrawn when the pressure at which the air is used is about ⅓ maximum. Fig. 14 indicates that very little can be gained in receiver weight by going to pressures above 1,000 psi, and that very little is lost at pressures down to 100 psi.

It is of interest to note that all lines and many cylinders, filled with air, store available pneumatic energy just as the receiver does. Hollow piston rods on large cylinders may also be used for receiver capacity, especially if the rod is loaded in compression. Landing gear structures have also been considered for possible receiver capacity.

(Concluding installment of this stimulating article will appear in June AVIATION*)*



Engineering Details Of the Rolls-Royce Nene Turbojet

First Americoe desige study of Britaie's most powerful production JP engine, a centrifugal-compressor throughflow unit developing 5,000 lb. static sea level thrust.

Newest British "River Class" turbojet developed from the original Whittle designs—the Rolls-Royce Nene—is also that country's most powerful production unit, having a static sea level thrust of 5,000 lb at 12,300 rpm at a weight of 1,550 lb. and overall diameter of 49.5 in.

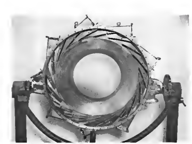
Using a two sided centrifugal compressor, nine throughflow combustion chambers and a single stage turbine, the Nene, or RB-41, was designed early in 1944 to Ministry of Aircraft specifications calling for an engine to develop a minimum of 4,000 lb thrust, with weight not to exceed 2,200 lb and maximum overall diameter of not more than 55 in.

Outward appearance of the Nene is quite similar to the General Electric I-40 (see page 51, Jan AVIATION), power plant of the Lockheed P-80 Shooting Star, the prototype of which was powered by a Nene.

Design of the engine around a double-sided impeller rather than the single sided unit employed by the Halford-deHavilland Goblin (described on page 78, Apr AVIATION) was dictated, Rolls-Royce engineers report, by the belief that a greater quantity of air can be consumed for a given frontal area. Use of the double sided impeller, they maintain, means that it can be 40% smaller in engine diameter for the same air consumption and thrust. Although use of the two sided impeller requires more clearance of the nacelle, Nene installations are said to require no more than 2 in. increase in overall diameter.

Impeller on the Nene has 29 vanes per side, with separate forged-aluminum, machined guide vanes. The front bearing, attached to a stub shaft, is roller type taking radial loads only.

Just aft of the impeller, and of slightly



Rolls-Royce Nene diffuser casing, showing nine outlets leading to combustion chamber. Outlets are cast integral with casing. Each outlet has two diffuser vanes

less than half its diameter, is a single-sided impeller which directs cooling air through a manifold and pipes to the center and rear bearings and turbine disk.

The thrust bearing, a deep grooved ball unit, is set behind the cooling fan near a spherical coupling which transmits axial thrust to the rear impeller shaft and consequently to the bearing itself. Axial thrust is forward up to approximately 8,000 rpm, aft above that speed. Torque is transmitted by a splined coupling around the spherical thrust unit.

Turbine disk is of solid steel, and into it are set 54 turbine blades made of Nimonic 80 steel. Blade roots are of the serrated "christmas tree" type. At the center of the turbine disk an integral flange, serrated at its circumference, is used to couple the turbine to corresponding serrations on the turbine shaft flange. Wheel and shaft spigot together and are secured by bolts passing through the respective flanges. This type of coupling is used to relieve sheer stress on the bolts at high speeds. In addition there are provisions for inserting eight equi-spaced balancing plugs on each face of the turbine disk.

Combustion chambers consist of an outer casing, perforated flame tube, and duplex burner. Converging on the discharge nozzle boxes, each chamber is located freely within its own box to permit differential expansion, a slight taper inside the boxes insuring a gas tight joint as the engine warms up.

Because of the large cross section of the combustion chambers, the igniter plug is well clear of the fuel spray on starting, and so, since ignition with the

General Specifications

Thrust at 12,300 rpm	
Static, sea level	5,000 lb
200 mph	4,620 lb
400 mph	4,890 lb
600 mph	4,450 lb

Thrust at 11,500 rpm	
100 mph	3,620 lb
300 mph	3,220 lb
500 mph	3,070 lb
Temperature combustion chamber inlet (increase)	200 deg C
Temperature combustion chamber (increase)	1,100 deg C abs.
Temperature drop turbine	175 deg C
Temperature, jet pipe	762 deg C

Dimensions

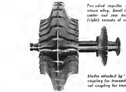
Length overall to exhaust cone flange	96.8 in
Length exhaust cone removed	62.6 in
Maximum diameter	49.5 in
Weight (inc accessories but without aircraft accessories or jet pipe)	1,550-1,600 lb

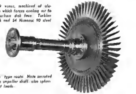
conventional plug would be difficult, a flame igniter is used.

This unit is comprised of a small atomizer embodied in one unit with an igniter plug. The atomizer is fed fuel from the low pressure side of the fuel system and is controlled by a solenoid-operated valve which gets current from the low tension side of the ignition system. In starting, the solenoid is energized simultaneously with the igniter plug, permitting fuel to pass to the atomizer and to be discharged as an easily-fired spray. The high tension spark from the igniter plug ignites the spray, the flame of which in turn lights the fuel spray from the pilot atomizer. An automatic time control cuts out the ignition system, and the solenoid valve is closed by a light spring which cuts off the fuel supply to the igniter plug.

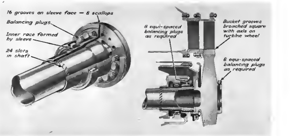
Exhaust assembly consists of nozzle, cone, and jet pipe, mainly double skinned with the space between skins filled with heat insulating material. Inside the nozzle is a conical fairing (the base of which masks the turbine disk) which is supported by four long transverse bolts inside streamlined fairings.

As is the case with the I-40, the acces-

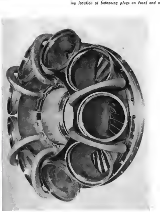




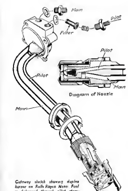
Two sided impeller (left) has 29 vanes, machined of aluminum alloy. Small impeller is fan which forces cooling air to center and rear bearings and turbine disk face. Turbine (right) consists of solid steel disk and 54 Nimonic 90 steel blades attached by "christmas tree" type roots. Note serrated coupling for transmitting torque to impeller shaft; also spherical coupling for transmitting thrust loads.



Detail sketches depicting method of cooling rear bearing (left) and showing location of balancing plugs on front and aft faces of turbine disk.



Discharge nozzle box and turbine guide vane assembly, showing the cooling air manifold.



Cutaway sketch showing duplex burner on Rolls Royce Nene. Fuel is delivered through pilot atomiser at low speeds, through main and at high speeds. Air is directed over jet face to prevent build-up of carbon.

sory case is attached to the front of the unit just ahead of the air intake. Driven at 0.41 engine speed, it contains drives for aircraft accessory gearbox, tachometer generator, two fuel pumps (right side), and starter motor (left side).

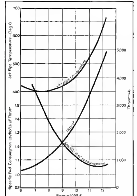
Lubrication system on the Nene marks a departure from previous Rolls-Royce practice, since a wet sump setup is used. Bulk of the lube oil is contained in a sump attached to the lower part of the accessory gear drive case. This sump houses pressure and scavenge oil pumps, two gauze scavenge oil filters, Purolator high pressure filter, pressure relief valve, and de-aerator.

Pressure pumps take the oil from the sump through the strainer and into the high pressure filter, from where it goes to the gear box to lubricate bearings on the rotor shaft. Scavenge oil from the gear box and front bearing drains directly into the sump; that from the rear bearing goes to the center bearing housing, then from both bearings to the scavenge pump via the sump base and gauze filters. Oil jets are used at "critical" points to operate in connection with restrictors to supply a controlled quantity of oil to the bearings, holding consumption to less than 1 pt. per hour.

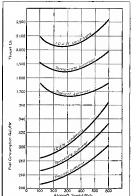
In the twin-pump fuel system, the aviation kerosene (plus 1% oil) is fed through a low pressure valve to a filter mounted beneath the accessory gear box. From here it goes to the pumps, the lower one of which is set 150 rpm. faster than the top governor setting. The pumps are of the oscillating multi-plunger type and have the piston stroke controlled by a swash plate, the angle of which is determined by a spring-loaded servo piston. Each pump has an overspeed governor which acts on the servo unit to limit pump delivery and keep rpm. within safe limits, but in the two-pump system, only the lower governor is used. Incorporated in the system is a barometric pressure control to vary pump delivery according to altitude.

At lower speeds, fuel goes directly from the throttle valve—which takes the combined pump delivery—to the pilot atomizers but, with increasing pump pressure due to higher speeds, the pressurizing valve opens and fuel goes to main fuel nozzles. Since the throttle is set to permit passage of fuel for idling when it is in closed position, the high pressure cock is used to stop the engine. Closing this cock completely shuts off the supply to the burners, and a drain passage is opened to allow the burner manifolds to drain back to the pump inlet. There is, in addition, a separate hole drilled in the high pressure cock for fuel to pass from the pressure line back to the high pressure fuel pump inlet to establish an idling circuit during engine shut-down and thus prevent undue pressure in the fuel line.

To facilitate installation in different aircraft, six engine mount attachment faces, with standardized brackets, are provided. Three alternative drive positions for aircraft accessory drives are on gearbox—upper and lower horizontal and upward inclined drive.

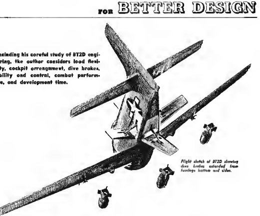


Performance curves, illustrating test stand results for specific fuel consumption, thrust and jet pipe temperatures



Curves showing estimated performance at 12,300 (maximum) rpm at 30,000 ft., under varying atmospheric conditions.

Concluding his careful study of BT2D engineering, the author considers load flexibility, cockpit arrangement, dive brakes, stability and control, combat performance, and development time.



Flight sketch of BT2D showing dive brakes extended from fuselage bottom and sides.

Skyraider's High Performance Stems From Pin-Point Designing

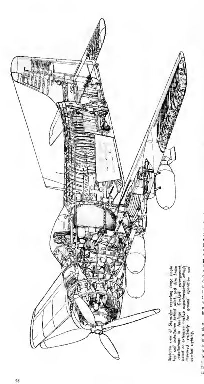
PART II

By E. H. Heinemann, *Chief Engineer, El Segundo Plant, Douglas Aircraft Co*

At the time of the conception of the Skyraider, a 1,000 lb. bomb was considered the normal bomb load. A 2,000-lb. bomb or torpedo was rated as an alternate or maximum overload. As the result of the Skyraider's underweight, increased lift, and improved stability and control at low speed, the normal bomb load of the craft is now 4,000 lb.

Carrying these stores externally instead of in a bomb bay has proven very desirable. Present arrangement of external bomb racks permits carrying bombs, torpedoes, or droppable fuel tanks in most any combination, hence greatly improving the flexibility and utility of the airplane. In addition to the three main bomb racks, rocket launchers are provided on the outer wings, further adding to the usefulness of the craft as an attack type for strafing and fighting missions.

It is realized that there are many who still advocate bomb bays for carriage, instead of arrangements for external stores, and it is granted that for many types, bomb bays are more desirable. However, with the Skyraider, the combat radius would have been no greater with internal bombs, assuming dropping of the bombs when over the target. A bomb bay would have given slightly greater speed in approaching the target, but the present arrangement (without a bomb bay) permits greater speed after bombs are dropped—when speed is mu-



Skeleton view of Skyraider revealing large single fuel cell installation behind pilot, and dive brake installations in fuselage. Cockpit arrangement, based on extensive mockup experimentation affords improved visibility for ground operation and combat sighting.

sidered to be the most important factor.

Lack of combat experience during peacetime had many bad effects. For example, the numerous inconveniences of military equipment—now remedied—were considered inherent factors.

Reports from combat pilots back from the Pacific clearly indicated that something had to be done to improve operational safety and reduce fatigue. To this end a very rigid cockpit design policy was established to provide for the safety of the pilot during all conditions of flight (including 40 G crash landing provisions) and to promote efficiency and convenience of operation of all controls and equipment without fatigue. To further improve safety of operation on the ground as well as sighting vision in combat, a forward and downward vision angle of 15 deg—twice the amount previously considered acceptable—was provided, together with a free blown cockpit enclosure.

To obtain the best possible cockpit arrangement and still meet the many conflicting requirements of combat aircraft, a total of five cockpit mockups were made and hangar-flown by Navy and Douglas pilots. Five mockups may sound expensive, but in the long run this number is believed to be economical, as evidenced by the relatively small number of change requests ultimately received.

Dive Brakes

In the selection of a suitable dive brake installation, four possibilities were considered: A reversing propeller, wing brakes, fuselage brakes, and parachutes. The reversing propeller appeared most promising, since it did not affect the air frame proper, but the idea was abandoned because there was no production propeller available having a sufficiently rapid rate of pitch change. Wing brakes were also abandoned because it was impossible to obtain sufficient drag without extending the brakes to the outer wing; also, every one of a wide variety of wing brakes tested by the company during the past few years were found to have the disadvantage of contributing to greater buffeting and poorer control in a dive, and because of the effect on wing surfaces resulted in lower maximum lift than clean wings without brakes. Parachutes were also ruled out.

Finally, the fuselage type brakes developed for the BTD were chosen. With these brakes, practically no adverse effect was found on the control of the BT2D in a dive. Wing lift was entirely unaffected, and trim change was found to be negligible. Also, these brakes proved to have the added advantage of being excellent maneuvering units for use during combat engagement, formation flying, and let downs from altitude.

It was with great reluctance that the decision was made to depart from the nose wheel type landing gear which proved so desirable on the BTD and many other Douglas craft. Need to save every possible pound as well as to provide for a greater variety of external stores (bombs, torpedoes, etc.) resulted in the choice of a rearwardly folding main gear and a tail wheel. It is still difficult to determine the exact weight difference between the two types of gears, but making the best possible allowances for bomb bay and wing changes it is believed that a net saving of approximately 100 lb. can be credited to the tail gear installation.

Although the tail wheel was considered most desirable for the BT2D, it is believed that every effort should be made to incorporate nose wheel gear on future types because of their safety during field landings.

Stability and Control

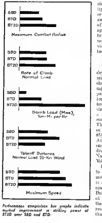
Stability and control requirements for carrier-based aircraft have always been considered more severe than for land-based types—requirements further aggravated by the dimensional limitations imposed on carrier aircraft by reason of deck elevator size. In most instances in the past, it has been found impossible to meet all the Navy stability and control specifications, thus necessitating compromises. However, in the BT2D project it was felt that the flying quality requirements could be completely met if an all-out effort were made.

To obtain necessary longitudinal stability, fundamental consideration was given to arrangement of all equipment and dead weight as far forward in the fuselage as possible, thus obtaining optimum tail length within the elevator size restrictions. To obtain desired elevator control forces, an adjustable stabilizer, electrically controlled, was provided. This permitted the selection of a smaller elevator area, thus giving lighter stick forces than would have been possible with a fixed stabilizer.

It is doubtful whether satisfactory stick forces could have been obtained on the BT2D without the use of power boost if stabilizer adjustment had not been provided. Free control longitudinal stability was improved through the use of horn type aerodynamic balance combined with a short elevator chord.

In carrier-based dive bombers it is perhaps more necessary than in other aircraft types to consider lateral and directional stability and control requirements as a single problem. This follows from the inseparable nature of these characteristics in both the low speed carrier approach and wave-off conditions and in the high speed level flight and vertical dive cases. For example, to obtain acceptable low speed flying qualities, it is essential to be able to pick up a dropped wing with either ailerons or rudder down to the stall. However, the required wing dihedral angle to accomplish this is usually excessive for high speed dives where application of rudder gives excessive roll and yaw. On the other hand, if the wing dihedral is too low, instability in roll will result in the flaps and gear-down cases.

After extensive wind tunnel tests both at Caltech and NACA Ames Laboratory at Moffett Field, a wing and tail surface arrangement was obtained which gives the Skyraider positive stability and control about all axes throughout the speed range from the stall to a terminal velocity dive. However, at the same time, maneuverability and control harmony was obtained through the use of aerodynamic balance on all controls and spring tabs on rudder and ailerons. To eliminate the undesirable variations in control and trim experienced with recent high speed airplanes using fabric control surface covering, metal covered control surfaces have been developed for the Skyraider—actually lighter in weight than the fabric covered surfaces on the BTD.



Performance comparison bar graphs indicate marked improvement in striking power of BT2D over SBD and BTD.

Combat Performance

To summarize the effect of all the weight- and lift-improvements upon combat performance, a bar graph is presented to compare the BT2D with its Douglas predecessors. (Security restrictions do not permit disclosure of performance figures.) Bomb load expressed in ton mi./hr has increased greatly over the SBD, and takeoff climb and high speed have been greatly improved over both SBD and BTD.

In addition to its most outstanding characteristic of great load carrying ability, the Skyraider's low wing- and power-loading, high load factor, stability, and control give it the added advantage of fighter-maneuverability for protection against enemy fighters. And its structural strength, vision features and maneuverability render it particularly well suited for strafing and for rocket attacks.

Record Development Time

With war pressures still on, the BT2D development was launched with determination to complete the project in shortest possible time. Engineering, tooling, manufacturing, and flight test departments of Douglas' El Segundo plant formed a team—the goal being to fly the first plane in 9 mo. Procedures were streamlined, coordinators appointed, and a policy adopted that design decisions could not be carried over to the next day. The result: Engineering was completed in 5½ mo. and first flight was made in 8½ mo.—two weeks ahead of schedule. And 9½ mo. later, the preliminary demonstration had been completed, including dives—and a plane was on its way to the Navy Proving Ground, Patuxent River, Md., for final acceptance trials.

Successful development of an airplane to meet the military requirements of a modern dive bomber, in so short a time, is a tribute to the excellent spirit of cooperation between the personnel of BuAer, NACA, and the various divisions of the Douglas organization. Although the war ended before the BT2D was ready for action, it is gratifying to know that the Skyraider is proven and ready.

MAINTENANCE

How to Service and Maintain The Marvel-Schebler Carburetor

Lucidly detailed here are the company-approved methods for operating and adjusting the MA-3SPA model—now newly offered in the civilian market. And included is a handy "shooting" guide to service troubles, their probable causes, and the remedies.

Of the updraft plain-tube fixed-jet type, this carburetor was designed by the manufacturer—Marvel-Schebler Div. of Borg-Warner Corp., Flint, Mich.—for use with the popular 6-cylinder Franklin, Lycoming and Continental aircraft engines. Two views of the units are afforded in our Figs. 1 and 2.

The design incorporates use of an accelerating pump, double float, manual mixture control, double venturi, idle fuel cut-off, back suction economizer, and safety throttle lever spring which keeps throttle open in the event of control linkage failure.

Accelerating pump insures smooth acceleration under all conditions by injecting fuel into the mixing chamber.

Manual mixture control and idle cut-off provide means of adjusting for all loads and altitudes and for stopping engine by shutting off fuel before switching off ignition. Details of working parts of this carburetor are shown in Fig. 3.

Principles of Operation

Idle system. When throttle (see Fig. 3) is slightly open, very little air passes through the venturi, and so the main nozzle does not discharge fuel. At the same time, however, the high vacuum above the throttle causes the primary idle nozzle to deliver air-fuel emulsion into that zone. Fuel from the fuel bowl passes through the mixture metering sleeve, fuel channel, power jet, and main nozzle. Thence it travels through idle supply holes of main nozzle into idle fuel restriction tube, where it is mixed with air from primary air vent.

Afterwards, all fuel and air continue upward through drilled passage having idle fuel delivery holes leading into throttle bore near throttle fly. At slow idle, only the uppermost hole is delivering to the engine. The hole below throttle will bleed air into the emulsion which eventually emerges into throttle barrel and combines with air passing throttle fly. Depending upon throttle position, small holes below throttle fly will either admit air into emulsion or deliver mixture from drilled passage.

Fig. 1 Marvel-Schebler Model MA-3SPA carburetor, showing throttle and mixture control levers.

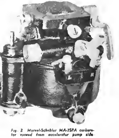


Fig. 2 Marvel-Schebler MA-3SPA carburetor viewed from accelerator pump side.

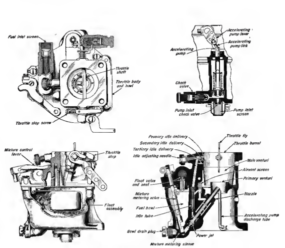


Fig. 3 Cutaway illustrations of carburetor with relative positions of the components depicted.

Idle adjusting needle controls the quantity of this rich emulsion and thus the quality of the idle mixture. Turning needle outward gives richer mixture, while turning inward makes mixture leaner. On idle, some air is drawn from below the throttle through the secondary idle delivery opening. This air blends with the idling mixture. Secondary idle mixture delivery begins as throttle is opened farther, blending with the primary mixture to prevent it from becoming too lean before main nozzle starts to feed. A tertiary idle delivery covers the broader idle range.

Up to about 1,000 rpm. all fuel delivery is from idle system. At higher rpm. increasing airflow causes main nozzle to start delivering fuel, while idle system fuel flow diminishes with decreasing suction as throttle is opened, until at 1,400 rpm. idle delivery is practically eliminated. At full throttle, all fuel flows through main nozzle.

Fuel Distribution

Because idle and main nozzle systems are connected by idle supply holes in the main nozzle, fuel delivered by either system depends upon the relative suction on both these nozzles, this suction being determined by engine load and throttle position. Main nozzle comes into action at any time when throttle is opened sufficiently to place engine under load, which causes a drop in manifold pressure.

Fuel to main nozzle passes through metering sleeve and fuel channel, then upward through power jet and nozzle bore, where it is mixed with air drawn through air vent and bleed holes. It is then discharged through nozzle outlet as an air-fuel emulsion. Air passing through nozzle air vent sweeps fuel from nozzle well and bore under very low suction, satisfying any sudden demand for fuel delivery. Air vent screen keeps out bugs and foreign matter.

Accelerating pump discharges only when throttle is opened. It provides additional fuel to equalize the sudden inrush of air caused by opening the throttle.

The pump plunger is moved downward by a lever connected to throttle shaft, thus forcing fuel through discharge tube into carburetor mixing chamber.

When throttle is closed, plunger moves upward, refilling pump chamber. If throttle is opened quickly, pump follow-up spring yields and thus prolongs pump discharge sufficiently to prevent over loading of the engine with fuel.

Mixture metering valve rotates in sta-

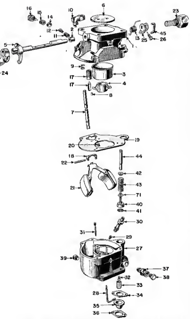


Fig. 4. Exploded view of carburetor. Key: (1) is throttle body, (2) bushing, (3) main venturi, (4) primary venturi, (5) throttle shaft and stop assembly, (6) throttle fly, (7) mixture metering valve assembly, (8) economizer jet, (9) spring, (10) mixture control lever, (11) spring, (12) screw, (13) spring, (14) retainer, (15) spring, (16) idle needle assembly, (17) float valve and seat, (18) float bracket, (19) gasket, (20) screen, (21) float and lever assembly, (22) float lever shaft, (23) strainer assembly, (24) throttle lever, (25) pump lever, (26) screw, (27) body and bowl, (28) pump discharge tube, (29) power jet, (30) nozzle, (31) idle tube assembly, (32) check valve assembly, (33) screen, (34) gasket, (35) housing, (36) flange, (37) check valve, (38) plug, (39) plug, (40) pump plunger and stem assembly, (41) spring, (42) seat, (43) spring, (44) rod, and (45) connecting rod.

tionary sleeve provided with a transverse slot through which the fuel enters between longitudinal flat on the valve and the edge of slot in the sleeve. When mixture control is in "R"—full rich—position, metering is controlled by the power jet, but in other positions metering is by the relative positions of the edges of the sleeve and valve. With the mixture control lever in "L"—full lean—position, no fuel is allowed to enter the nozzle. This provides what is called "idle cut-off" to prevent accidents when working around a hot engine.

Back suction economizer consists of passages connecting the throttle barrel with the sealed fuel bowl. The position of the openings into the throttle barrel are so placed that, in the cruising range, manifold suction is transferred through the passages to the fuel bowl. This suction is modified by the atmospheric bowl vent, with the result that a differential suction is created in the fuel bowl, varying both with engine suction and atmospheric pressure. This back suction diminishes fuel flow from fuel bowl to nozzle and idle system and provides an "economy" mixture at cruise.

Starting

If engine is cold, set mixture control "full rich", prime engine according to manufacturer's instructions, and set throttle so that throttle stop is 3/32 in. from stop screw. This will open throttle about 1/10. Turn engine over two or three times, *with switch off*, to draw combustible mixture into cylinders. Turn switch on and start engine. Because this throttle setting gives richest mixture, engine should idle satisfactorily under these conditions. Allow engine to warm up until it is *firing* evenly, before opening throttle farther.

If engine is warm, set mixture control in "full rich" position. Pull throttle lever back against stop screw. If engine has just been running, it should start on first turn after ignition is switched on, but if it has been standing for a short time, it may be necessary to turn engine a few times before switching on ignition.

Note that a warm engine should idle smoothly with throttle in idling position. A hot engine should not be primed, and throttle should never be "pumped"—opened and closed several times—when starting, since this causes raw fuel to be deposited in carburetor air box, resulting in a dangerous fire hazard in case of backfire.

Use of Manual Mixture Control

Below 5,000 ft. altitude, mixture control should not be used. Above this point, mixture control is adjusted by moving slowly in and out, with throttle at cruising or full open position, until highest rpm. are attained. Mixture will then be correct for all loads and throttle positions at that altitude. Mixture control should always be moved to full rich position when coming in for a landing, so that full power will be instantly available if required. If this setting is not used under these conditions, engine may overheat because of too lean a mixture, or it may actually stop by "starving".

In stopping, pull mixture control to "idle cut off" or "full lean." Open throttle slightly from idle, making engine speed about 1,000 rpm. Turn off ignition only after engine stops from lack of fuel. Manifold and cylinders will then be full of air, after which mixture control may be returned to "full rich" for starting.

Service Inspection

Gaskets and fuel line should be inspected daily for evidence of leakage. If any signs of leakage are seen, defect should be remedied immediately, because there is a dangerous fire hazard in this condition even when plane is standing in the hangar with the engine not running.

Idle adjustment. After checking all other points on engine, if it is found necessary to adjust carburetor, following method is used. Warm up engine and set throttle stop screw so that engine idles at about 550 rpm. Turn idle adjustment out until engine "rolls" from rich mixture, then turn needle in until engine misses from lean mixture. This will give the extreme range through which the engine will idle. Now turn needle out again until setting is richest on which engine will run smoothly. This adjustment will give a slightly slower idling speed than a leaner mixture with same throttle opening, but it will also give smoother idling.

Change in idle mixture will affect idle speed, and it may be necessary to readjust idle speed by resetting throttle stop screw. Idle adjusting needle is usually set open between ¾ and 1 full turn. Care should be taken not to damage the idle needle seat by turning in the needle too tightly, because adjustments are difficult to make satisfactorily unless this seat is in good condition.

Float height. By removing throttle body assembly and turning upside down, the float height can be checked. This causes floats to fall into position which closes fuel valve, enabling setting to be measured. Height from float top to top of cover gasket should be 7/32 in. Top surface of float should be parallel to surface of gasket. Both floats should be checked.

Accelerating pump. Pump link may be placed in any one of three holes in pump lever, in order to vary length of stroke. Normal position of link is in No. 3 hole (giving longest stroke), though No. 2 hole may be used in extremely hot climates or with high test fuels. No. 1 hole (giving shortest stroke) is rarely used.

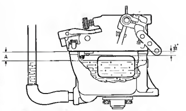


Fig. 5. Method of testing float valve and seat. Distance "A" should be exactly 11/16 in. for this model. Float height must be 7/32 in.

Testing

Connect carburetor to fuel supply under pressure specified for engine installation. Then attach rubber tube to carburetor drain and insert glass tube, as shown in Fig. 5. With 24 in. pressure head on fuel, distance "A" should be 11/16 in. and float height 7/32 in. If float level rises, this indicates leakage around seat. If leakage cannot be corrected by cleaning, float valve and seat should be replaced by a matched set obtained from Marvel service station or factory at Flint, Mich.

Accelerating pump is tested by operating throttle lever three or four times through its full stroke. This should expel a fine spray of fuel through discharge nozzle each time throttle is opened. Operator should, of course, stand in a position where fuel spray will not be directed at his eyes and face. If discharge is weak, pump plunger requires replacing or repacking, but if no fuel is discharged, inlet check valve must be renewed or serviced. Discharge tube will give either one of the above effects if it is clogged, so this part should be checked to make sure that it is clear.

Service Troubles and Their Remedies

Trouble	*Probable Cause*	*Remedy*
Engine sputters or dies	Water in Carburetor Defective fuel pump Dirt or ice in line Mixture too lean	Drain carburetor bowl Replace or repair Disconnect line and blow out Adjust idling needle
Engine races and will not idle properly	Throttle not working Mixture too rich Defective fuel pump Throttle stop screw improperly set	Free controls and linkage Adjust idling needle Replace or repair Adjust (see text)
Engine will not start	Defective fuel pump No fuel Ice or dirt in gas line	Replace or repair Refuel Disconnect and blow out fuel line. Drain carburetor
Loss of power	Dirty air cleaner Improper grade of fuel Accelerator pump jams Icing of carburetor and manifold	Service cleaner element Use right grade Replace plunger assembly Reset heat control

Convenient Engine-Trade Plan Offered by Continental

Featuring attractive flat rates, newly established service immediately provides factory-rebuilt power plants as replacements for plane owners' used engines. And with dealers at 200 fields already participating in system, flyers can readily arrange the exchanges in their own areas.

Except in the case of the largest operators, engine overhaul has been a rather long process, using up an excessive number of man-hours because of lack of the highly specialized machinery required for economical working. To reduce the resultant expense to aircraft owners and at the same time to provide the advantages of quick engine replacement, Continental Motors has worked out a plan whereby any of the company's used current engines may be exchanged by a plane owner for a factory-rebuilt unit carrying the same guarantee as a new engine.

Because of economies made possible through production line methods and through the same factory processes used in building new engines, charges for this exchange service are lower than would be possible for comparable work done on a unit basis. Figures quoted for stripped engines are: Model A65-8, $247.50, A75-8 or A75-9, $271.80, and C75 or C85, $288.00. These rates assume that the engine shipped into the plant is in running condition. If otherwise, repairs are made and charged for at 50% more than list price for such parts as are required to put the power plant back in runnable condition.

Disassembly line at Continental's Muskegon, Mich., engine rebuilding plant

Factors Governing Equipment

Accessories also are exchanged on a flat rate basis, with exception of spark plugs, ignition harness, air scoop, oil sump, and other expendables which are replaced with new items. All quotations include labor, new or remade parts, and packing in engine shipping box.

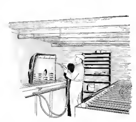
Equipment and accessories for an engine vary considerably with the type of aircraft with which it is used, therefore these parts are removed before shipment to the factory and are later installed on the replacement engine.

To make this exchange service as widespread as possible, Continental Motors has arranged with over 250 dealers at about 200 airports to have exchange engines available, thus wherever they may be, aircraft users will be able to obtain replacement engines conveniently when the need arises.

An additional advantage is that regardless of the number of flight-hours on the plane's log, the owner can always have an engine which carries the same guarantee as a new one, but at a fraction of new-engine cost.

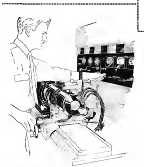
Manifold Repair Fixture Checks Inaccuracies

• For checking exhaust manifold repairs for alignment and accuracy, C&S built this special bench, to which completed work is bolted. Any distortion or other fault, can be immediately discovered and remedied while part is on fixture.



Compact Washing Booth Saves Many Steps

• Planned to save as much space and lost motion as possible, this AAA washing booth features a soaking tank (bottom left) over which is a drainage and wash rack. On ceiling above rack are fixtures for hoist equipment used when lowering parts into tank. At right is rack of steam-heated pipes for rapid drying of washed parts. Shelves carry supplies and spares.



Test Bench Features Many Improvements

• To improve efficiency of standard generator-and-motor test bench, PCA's electrical department introduced several changes. Sponge rubber blocks were added between holding clamps and machine being tested; leads were fasten together to prevent chafing from vibration; mahogany backboard was used to support instrument boards, thus permitting clips and brackets to be screwed to rear side for securing leads, and all master switches were mounted directly beneath instruments which they control.

It'll Pay You to Promote LIGHTPLANE INSURANCE

SECOND OF TWO SPECIAL ARTICLES*

By R. L. TEMPLETON, Aviation Insurance Consultant

This practical perspective for the airport operator considers the various liabilities—property, public, and passenger—to which the plane owner is subject; also affords a lucid examination of the protection which insurance affords. Included is a handy guide to the provisions of the several states, and specific prices and limits of the policies are noted.

IT CERTAINLY MAY BE SAID that aviation insurance builds double values—for such insurance benefits the operator himself as well as his plane owning customers. Moreover, these two advantages work together to promote the well-being of aviation as a whole.

The operator's customers benefit because they will be adequately protected against damage claims and can, accordingly, fly with more ease of mind. And the operator himself benefits because he thus gains a more staunch clientele. He may also profit by offering an insurance service. Finally, it is to be noted that, overall, "insured planes insure the business."

A plane owner who is adequately covered by insurance will not be so set back by an accident or be bankrupt via claims for damages—but an uninsured owner who has become involved because of airplane damage or finds himself enmeshed in a lawsuit may be forced to sell out and quit flying—and the operator loses a customer.

Since aviation insurance represents a fairly large item of operating expense for the plane owner, it offers the operator a profit-promising sideline which will broaden and improve his service. The great majority of our postwar plane owners will be newcomers who have had little experience with airplanes or airplane insurance, and they will, naturally enough, look to the operator for guidance.

Hence, the operator himself needs to be well-informed on aviation insurance to answer questions, and in many cases he will want to have a well qualified agent to service his customers. He may also consider adding an insurance department to his business. It's best, too, if the agent he selects has done some flying, so that he knows the risks to which an average plane owner is vulnerable. The larger airport operator might well establish a fully staffed office to handle both the insuring and financing of aircraft. Such a service would be distinctly convenient for the patrons.

The two prime types of aviation insurance are: (1) Aircraft "hull" insurance, which covers damage to the plane, and (2) liability insurance, which protects the plane owner against claims for injuries to passengers or to third persons outside the plane, or for plane-caused damages to property. Our previous article described the various types of "hull" insurance and their respective costs, the present article is devoted to liability insurance.

Legal Responsibilities

The average plane owner will, of course, have a general idea of his responsibility for damages and his need for liability insurance to protect himself against claims. But when he fully understands the extent of his liabilities, he will be much more firmly convinced of the desirability of this form of protection. In discussing the subject with him, the airport operator will do well to point out the specific provisions of state legislation.

The pilot is imposed with "absolute" liability or "presumed" negligence for injuries to third persons and for damages to property caused by his airplane by express statutes in 19 of the 48 states. Georgia and Maryland have adopted "presumed" or prima facie negligence statutes, and 17 states (Colorado, Delaware, Indiana, Michigan, Minnesota, Montana, Nevada, New Jersey, North Carolina, North Dakota, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, Wisconsin, and Wyoming) have adopted the "absolute" liability provisions, Sections 4 and 5, of the Uniform State Law of Aviation.

Section 4 provides that the pilot shall be liable for actual damages incurred by a forced landing. Section 5 provides that "the airplane pilot or owner shall be liable for all damages that are caused by the ascent, descent, or flight of the aircraft, or the dropping of any object therefrom, whether such owner was negligent or not, unless the person injured was contributorily negligent."

Five other states with aviation liability legislation (Arizona, Arkansas, Idaho, Missouri, and Pennsylvania), have statutes which provide that the plane owner's liabilities to persons and property on the ground shall be determined by tort law (a tort is defined as any private or civil wrong by act or omission giving rise to a remedy which is not an action of contract). In deciding suits for damages or injuries caused by airplanes in these five states, the pilot (or owner) would very likely be held liable under the tort law doctrine of res

(Turn to page 155)

* Mr. Templeton's initial article appeared on page 82 of Feb. AVIATION.

...TO MAKE MAIN STREET CONSCIOUS OF YOUR AIRPORT

PART IV OF A SERIES

The airport must first sell itself on its appearance in order to attract the public, interest prospects and build customers. (A S Bergen photo)

By CHARLES A. PARKER, Flight Service Division, Robinson Aviation, Inc., Teterboro Air Terminal, Teterboro, N. J.

Telling how to attract people to the field, and how to make them really like it when they get there, this practical feature examines all the varied phases of airport promotion. And punctuating it are a score of proven tips—everyone a ready-to-work business-builder.

NO OPERATOR CAN AFFORD to sit back and wait for business to come to his airport. For the fact is that any enterpriser must take pains to publicize his services before the maximum number of the right people—if he intends to show the greatest financial return. This calls for a concerted and effective marketing effort.

Immediate postwar demand will tend to level off after a reasonable time. And regardless of the sellers' market that will exist for a while, the wise operator will plan a marketing and promotional program, with intent to "educate" prospects as well as to obtain direct sales.

The importance of the salesman should not be underestimated, for he can do much to make an enterprise a success. In truth, he has often been the real pioneer in placing a new product before the public. Because aviation has borne more than its share of public doubt and indecision, the role of the salesman assumes additional importance.

It is unfortunate that airfields are not always located on a beaten path. Too frequently they are remote and at times even difficult to reach, thus making harder the operator's job of "selling the airport to Main Street." Promotion and sales effort, under these circumstances, will have an even greater importance than in the case of the man whose enterprise is more centrally located.

One frequent prewar complaint was that aviation did too much selling to aviation people, and in a measure this was true. The need to reach outside the so-

called "aviation circle" should constantly be borne in mind. From the day business starts, all marketing efforts must be accompanied by a genuine "service to the customer" attitude. Certainly, perfection has not been reached; accordingly, it's a rare operator who cannot profit by giving serious consideration to the matter of how he's handling and serving his clientele. No matter how many customers stand at the counter, operators will do well to sell, as well as serve. That's demanded to keep the trade.

The airport owner has to sell both a service and a product, each with its own particular problem. And each is linked with the other—for the product (the airplane) is dependent to a considerable extent upon the service for its success. The sale of an airplane coalesces with the further sales of service.

Without owning any aircraft, the operator of an airport can offer fuel, storage, supplies, and mechanical service to plane owners. Miscellaneous concessions to vendors can also be leased. If the owner does not desire to operate aircraft, a concession can be granted to some pilot to carry on flying activities at the field. Even aircraft dealerships have been maintained without flying activities, but it is doubtful if this is feasible, except in rare instances.

The smaller type of operation will comprise the conventional services—namely, instruction, rental, sightseeing, and charter flying, while other activities may develop from these basic factors. The operator may not be in a position to invest in aircraft for sale nor make deposits that will bring him a dealership, and in this case he might act as a broker for several makes through arrangements with the dealers for his area. However, if he purchases and operates a new airplane, he will probably have some sort of dealership arrangement.

With the present trend in aircraft sales, almost every operator will want some affiliation, either as representative or dealer. A distributorship, while desirable, will probably be beyond the reach of the smaller type of aviation enterprise. Aircraft sales, with the attendant supply and maintenance, should eventually become a basic activity of operators, with flying services conducted more and more as a means to promote sales.

For years the barnstormer traded almost entirely upon "first-time" passengers, his stock in trade being the unusual experience of flight. Since those early days, the aviation field has widened, but people will still buy first hops, and on the development of their desires will be built the private flying industry. Then as aviation advances into the future, private flying should fall more and more into the "solid" category of utility.

The barnstormers put in some pretty good selling effort. Though some of the tactics they used to get people into the air would have done credit to Barnum himself, the fact remains that they did get people to buy flights. Present business might take a small page from this historical period and profit thereby, not through the circus performance that then was aviation, but in this basic matter of selling.

There are several factors which have a decided bearing upon the sales effort. Naturally, it is essential to have airworthy equipment, competent pilots, and good maintenance, with sound methods throughout—all elementary parts of a first class airport operation. Business-like and attractive appearance counts, too—in other words a "good front" must be presented. With this accomplished, there comes the necessity of maintaining the right attitude and recognizing at all times what service-to-the trade means.

The operator must have a correct understanding of what should be provided by such a semi-luxury business, and he should create the same attitude in the public mind toward himself, toward his business, and toward aviation as a whole. As for airport attractiveness and good appearance of planes and other equipment, nothing is more convincing to the prospects. An airplane need not be a new one to inspire confidence, but it's essential that it look well.

No matter how small an operator's headquarters may be, and despite the choice of materials for their construction, they can still be "dressed up", and this goes for the personnel, as well. All that's required for "policing" is a broom and a rake. That is, after some paint and a little effort have been employed. People like clean quarters and clean equipment, and of course a clean airplane helps to sell itself.

It should be constantly remembered that the personal plane is a semi-luxury product. It follows that if the field operator wants to get in on the class of trade which can really contribute to his success, then all factors must be in keeping—both tangible and intangible. Good service must be given to everybody. This means attention to the customer's needs, being prompt in appointments, standing by agreements, and so forth. In each dealing, the customer should be made to feel that he is the most important consideration for the moment.

The smart proprietor will see that the customer gets what he wants, when he wants it, and as nearly the way he wants it as is possible. A little extra, now and then, in the way of service can show big returns, and the operator may arrange this without contravening his regular business methods. It has already been shown that it is easy to have systematic procedure in all phases of the operation and sticking to this system will do much to enhance the quality of the business.

The foregoing can be summed up under the head of continued customer satisfaction. Dissatisfied customers not only mean loss of revenue, but are bad advertising. The writer has spent much time and effort to prevent dissatisfaction on the part of both transient flying trade and aircraft owners, knowing that it is sometimes more difficult to keep customers appeased than it is to sell to them in the first place.

Combination business office and salesroom of Lehigh Aircraft (Allentown-Bethlehem Airport) tries to impress upon customers that this is an efficient business organization

Extremely unwise is the operator who, after selling aircraft, then fails entirely to follow through with the customer. The amount of attention and service given to customers by the automobile trade will be a good example of how this kind of business should be built and maintained.

After advertising and promotion has provided sales leads, the personal contact and follow-up are essential. Some prospects must be worked on by repeated calls before a sale can be made. The number of sales are almost in direct ratio to the amount of effort expended in this manner.

Some services, such as charter flying, can only be sold to a limited extent, so it becomes necessary to have the company's name displayed in the right places, so that customers are attracted to call when their need arises. Student flying and subsequent rental flying should be developed by advertising and contact work, the same as aircraft sales and the attendant maintenance and supply business.

Comfort facilities such as this powder room at Hoosier-Parks Airport, Indianapolis, go far in holding trade of particular customers.

While any public talk, roadside sign, or good word passed along by a satisfied customer may be thought of as advertising, the usual media considered are the commercially written or spoken word. Advertising offices divide all the foregoing into "mass" or "class" media. Mass media, such as posters, signs, and window cards, can be used to advantage, though it may not be easy to place such items in desirable locations. Billboards reach a specific section or flow of the auto-owning higher-income traffic, but are somewhat expensive. Bus and car cards are not particularly applicable to aviation sales purposes. Newspaper advertising on any considerable scale may be costly, however in smaller communities a local paper may be used to some extent. In this case, the fact that the airport is an advertiser will be an excellent reason for obtaining free publicity in the form of news items. A college paper can be an excellent medium, particularly if the college has a well-to-do student body.

There is little evidence that radio, with its rather high rates, has been used to any extent by the aviation business. Some free radio time may be possible because flying can still provide some rather unusual material. In any event, radio advertising should be supplemented by other publicity.

Class media will be of most interest to the operator, because he is definitely after a class market.

Magazines—except for the specific aviation publications—are generally outside the operator's scope, though aviation schools, seeking national enrollment, use them. The writer has employed classified columns of aviation magazines successfully in selling specialized types of aircraft.

Other Approaches

Direct mail enables sales effort to be concentrated on a particular group. It enables the smallest operator to compete with the largest through a direct control of a list of people to whom he sends his message. The type of material sent can range from a few personalized letters to thousands of penny cards. Success of direct mail depends upon the care with which the message is prepared, the accuracy and completeness of the mailing list, and the adequacy of the follow-up. If these points are remembered, direct mail advertising provides the operator with an economical coverage and appears to offer him the most return for his money. Any descriptive literature used in direct mail can also be used for over-the-counter distribution at the airport.

Personal contact with good selling applied to the leads developed by direct mail, may carry the sale through to a finish. Theater and convention programs and special or seasonal editions of local publications are usually quite selective and may be utilized to advantage.

Directories can be useful to list the operator's services, particularly the classified section of the telephone directory. Calendars, provided they are attractive, can be valuable, representing all-year advertising. Blotters and small desk calendars serve as excellent reminders. Gifts can be used to advantage on a selected list, creating much goodwill, especially at the Christmas season.

In all printed advertising, it is essential that the copy should be alive—both attractive and imaginative. A successful hotel man once said, "Don't sell steak, sell *Sizzle*!" Certainly, aviation has plenty of sizzle that can be used in sales. "Flying—the sport of sports", "It's fun to fly!" "Flying opens new horizons", and "Let's take a flying lesson!" are samples of headings which have "worked". From such heads, copy should follow that will make the ad a personal appeal to the reader that will make him picture himself at the controls. Appeal should be made to emotion as well as logic, and to imagination as well as fact. Facts and statistics may make interesting reading for the confirmed pilot, but they have little appeal to the newcomer. This applies to the sales talk as well as to written advertising.

In all advertising it is wise to allocate an amount of money in advance for a season or a year—to prevent hit or miss dribbling away of money through having no planned program. As the business grows, it may be found desirable to turn to a professional agency to conduct the company's advertising.

Low-Cost Reflectors Simplify Runway Lighting

By R. H. MUEHLBERG, *Minnesota Mining & Manufacturing Co.*

Portable, reluceot eolts—ootgrowth of auto-highway night markers—provide ecooomical reeway illumioetioe. System cae he set up hy ooe moo le holf oo hoor.

CONSEQUENCE of the present rapid growth in instrument instruction will be that airmen will tend to prolong their flying for a few hours after sunset. And to make this possible, it's essential that many more ports have illuminated runways.

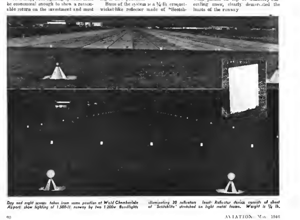
Obviously, such lighting systems must be economical enough to show a reasonable return on the investment and must also be sufficiently rugged so that maintenance won't eat up the profits. Current consumption should be small, consistent with adequate illumination.

Recent experiments by CAA at Minneapolis and Rochester, Minn., airports have shown that low-cost runway lighting is now practical.

Basis of the system is a ¼-in. croquet-wicket-like reflector made of "Scotchlite", the same material which is used in many highway reflecting markers and signs made by Minnesota Mining & Mfg. Co. These reflectors are spaced at 100-ft. intervals along both sides of the runway, 30 being sufficient for a 1,500-ft. strip. If a change in the wind requires use of another runway, the entire lot of reflectors can be replaced in the new position in less than 30 min. Their light weight and comparatively small size permits one man to carry a full set.

Light is provided by one floodlight for each side of the runway, with the exact amount of illumination decided according to atmospheric conditions—maximum being about 1,000w. Considerably less might be effective in higher altitudes.

Because there is no glare from the reflector system, pilots easily see the surface of the runway when landing. During the experiments, transport pilots using Wold-Chamberlain stated that sufficient light was provided by the planes' landing lights, also that the reflectors, when placed on top of boundary-concealing snow, clearly demarcated the limits of the runway.



Day and night scenes taken from same position at Wold-Chamberlain Airport show lighting of 1,500-ft. runway by two 1,200w. floodlights illuminating 30 reflectors. Inset: Reflector device consists of sheet of "Scotchlite" stretched on light metal frame. Weight is ¼ lb.

CAA Integrated Maintenance Meets Opposition

Recently proposed plan by CAA to organize and operate its own storage and repair bases in different areas of the U. S. has been severely criticized by leading aviation bodies and the U. S. C of C.

Following quotations illustrate the viewpoints:

"Storage and maintenance of CAA-owned aircraft can be satisfactorily accomplished, as in the past, as an activity of private enterprise." — *W. T. Piper, Chairman, Personal Aircraft Council of ATA*

"Plan would be wasteful of public money. . . There is no assurance CAA will not grow into an overhaul setup for other agencies of government."—*Col. Roscoe Turner, Pres. NATA.*

"ADMA will go on record wholeheartedly as being entirely opposed to the CAA plan to enter storage depot-repair base business."—*Arthur S. Brown, Representative.*

"We are on record, and have been for a long time, as being unalterably opposed to government competition with private enterprise. . . The issue involved is a fundamental one. Everyone interested in advancement of aviation must fight to preserve it."—*Lowell Swenson, Mgr., NAA.*

"It is wasteful of private money. The plan and its extension threatens to slam the door of opportunity in aviation"—*ATS, Resolution of Board.*

U. S. C. of C. claims that repairs can be made more efficiently and economically by private contract, pointing out that Federal Code, Annotated, Title 41, Sec. 5, provides that contracts of less than $100 can be let without advertising for tenders, etc., and that such contracts could well be let on an annual or semi-annual basis. Chamber also states that this procedure would not interfere with CAA supplying parts for repairs from a central storage base.

First Region—Salair Flying School, Piper, Republic, Continental and Edo agent at Teterboro Airport, N. J., has completed a new hangar and apron. Firm will continue its use showroom at 382 W. 57 St., N. Y. C. . . . Ercoupe is now being sold at Rockaway Airport, N. Y., by the Edgemere Aviation Corp., which is also Gulf and Piper agent. At same field, Trans-Eastern Airways sells Commonwealth and Bellanca planes. . . . Wiley Prat, Jr., of Lehigh Aircraft, Allentown-Bethlehem Airport, Pa., reports that a customer landed an Ercoupe on Hamilton St., Allentown, and taxied to a parking lot. Though given a "ticket", pilot was turned loose by court. . . . Farley's Air Park, New Baltimore, N. Y., Taylorcraft agent, operates land and seaplane base on Hudson River. Owner J. W. Farrell has constructed picnic ground and swimming beach. . . . John R. Nelson is building a new airport at Croton, N. Y., with two 2,500-ft. runways. . . . Based at Oyster Bay, N. Y., a group of AAF veterans is starting a commuting service to N.Y.C. . . . New promotion idea by J. R. Fletcher of Franklin-Norfolk Airport, Mass., calls for free solo courses award via competitive exams at local high schools. Field has 2,500-ft. runways on well drained sandy soil. Brick repair shop is under construction. . . . Schroon Lake, N. Y., will be connected to N.Y.C. by airplane service operated by Monarch Airways, based at Brown Swan Club on Lake. . . . Lake Susquehanna Airport, Blairstown, N. J. is now approved advanced flight and instrument school giving Link training. . . . Tomlinson Field, Skowhegan, Me., is enlarging its seaplane base facilities and has built a parachute loft. Staff includes aircraft inspector and two flight examiners. . . . Wm. F. Kinser of Yonkers Seaplane Base, N. Y., has added 124,000 sq. ft. to the property with 500 ft. front on Hudson River. . . . Cliff Leuthold of Columbia Aircraft Services, Bloomsburg Municipal Airport, Pa., reports firm now has CAA rating as composite and metal aircraft, engine, and instrument repair agency.

Second Region—Tennessee State Bureau of Aeronautics is publishing a quarterly "Tennessee Air Progress" devoted to development of aviation in that state. . . . Milford Airport, Dickerson Lane, Falmouth, Ky., is now Aeronca dealer. . . . Paris Aviation Club, Ky., has elected Wm. Harper of Carlisle pres., Chas. Langfel v.p., R. Sheul secy., and S. Wilson treas. Membership is now 27.

Third Region—Victory Field, Warsaw, Ind., Aeronca, Fairchild, Trimmer, Continental, Firestone, Gulf and Motorola dealer, is operated by Sky Pilots, Inc., Rev. Paul C. Harford, Mgr. . . . Illinois Air Pilots Assn. met recently in Chicago in protest against state registration fee. . . . NATA regional convention at Chicago held a meeting under leadership of J. R. Harrington, regional pres., to formulate plans for future development. . . . Arthur H. Starnes has opened a parachute loft at 208 N. Wabash, Chicago. . . . Flying Farmers of Iowa recently met at State College, Ames, Iowa.

Fourth Region—Boyd Aero Service, Santa Fe Old Municipal Airport, N.M., has arranged for airstrips in neighboring mountains for tourist landings and is giving mountain-flying instructions. Firm also has a U-Drive-It auto system for travel in places where planes cannot land. Airport may be reached via radio beam which steers clear of mountains. Boyd is Piper and Continental distributor for region. . . . Talley Auto Supply, Roosevelt, Okla., now has agency for Luscombe, Continental, Philco, and Goodrich.

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AS THE OPERATORS SEE IT

Maybe you've run into a sales and service snag, face some overhaul hurdle, are grappling with a flight teaching toogle, or seek guidance in the maze of maintenance. Whatever the perplexity, it's "fair shooting" here in our operators' corner. Answers, and criticisms of answers, will be paid for at AVIATION's usual rates. Welcome, too, will be photos or sketches which "point up" the problems.

QUESTION 2 —*Do you make a landing charge when a visiting pilot uses field facilities for a few hours but does not buy fuel or service? What are your reasons for doing or not doing this? Do you find that this landing charge is expected by visitors? —R.K.*

Answer: "Even when visiting pilots stay most of a day at the airport without spending anything, we make no landing charge, since we consider the goodwill worth more than any such small amount these airmen might pay to come in. We find that eventually they all return and bring others with them. . . So far, we have not met any pilots who expected to pay for use of the field for landing."—*Frank S. Pettenger, Lake Susquehanna Airport, Blairstown, N. J.*

Answer: "We are definitely opposed to charging for landing at any time—for these reasons: First, we ourselves don't expect to be charged when we land at other fields, and second, we want to make visitors feel that they are welcome to our field and not merely regarded as just so many customers. We have yet to find a private pilot who acted as though he expected to pay for landing."—*Joseph Alto, Rockaway Airport, Edgemere, L. I., N. Y.*

Readers Are Invited to Answer—

Question 3.—Which of these sources of new business do you consider the best: (A) Customer goodwill, (B) billboards or (C) local newspaper advertising? What has been your experience with these media? Have you used successfully any other method for attracting business to the airport?—D H

Artist's conception of completed Northrop XB-35 Flying Wing shows unusually smooth aspect of AAF's latest very-heavy bomber. Powered by four 3,500-hp-plus P&W Wasp Majors turning 8-blade coaxial Hamilton Standard Superhydramatic props, craft is stated to have 10,000-mi plus range. Remote-control gun turrets are fitted in center section and both above and below 172 ft. wing.

NORTHROP XB-35 FLYING WING SET FOR FLIGHT TESTS

With completion of Northrop's XB-35 Flying Wing, preliminary details are now available on one of the most ambitious AAF aircraft projects ever attempted, an all-wing long-range, very-heavy bomber with a range surpassing 10,000 mi.

Spanning 172 ft., and with 4,000 sq ft. of wing area, the giant craft is said to be capable of operating at an overload gross weight of 209,000 lb. Design empty weight is given as 89,000 lb., and design loaded weight as 162,000 lb. Four Pratt & Whitney Wasp Majors (one pair each of R-4360-17 and R-4360-21 series) equipped with single-stage GE turbo-superchargers develop well over 3,000 hp each. They are fitted with four eight-blade Hamilton Standard Super-hydromatic reversible pitch counter rotating propellers of 15 ft. 4 in. dia. A crew of 15 (inclusive of 6 alternates for long missions) is designated. Crew positions are in a pressurized central nacelle. Cost of the prototype is estimated as about $13,000,000, and Army contracts call for 15 such planes.

A new high-strength Alcoa aluminum alloy is used in the craft's fabrication. As the name Flying Wing implies, the XB-35 has no conventional fuselage or tail surfaces. The boomerang-shaped wing has a root chord of 37 ft. 6 in., tapering to 9 ft. 4 in. at the tips. Overall length of the craft is 53 ft. 1 in., and overall height is 20 ft. 1 in.

The control systems developed for the Flying Wing are among the interesting features of the craft. No vertical surfaces are used. Elevons (combination elevators and ailerons), each more than 35 ft. long, are utilized. In place of rudders, huge "clam-shell" split flaps are independently actuated by pedal pressure to set up sufficient drag to help swing the bomber around. An advantage of this type of control is that it creates no additional drag when it is not in use. Landing flaps, each more than 29 ft. long by 6 ft. wide and containing about 175 sq. ft. of area, can be depressed almost normal to the slipstream. Long slots run parallel to the leading edge near the wing tips. So as not to impair the plane's efficiency at high speeds, these slots are faired over by special panels which are automatically actuated to open at stalling speeds.

Controls are actuated through a full-boost hydraulic system coordinated with Northrop-designed pneumatic loading devices to retain pilot's feel. It is stated that without this "feel" system the pilot could, with two fingers, exert the booster controls sufficiently to tear off the control surfaces. The boost devices use 92 hp. tapped off from the Wasp Majors to work eight hydraulic motors. The special Minneapolis-Honeywell automatic pilot has four motors.

Fully retractable tricycle landing gear is fitted with 5½ ft. dual wheels on the main gear and a 4 ft. 8 in. nose wheel. Actuation is by electric power, which also operates landing gear doors, bomb bay doors, gun turrets, radio, and other equipment. Four alternators geared to the Wasp Majors supply 400-cycle 3-phase 208 v. a.c. at the rate of 120 kw./hr. Ten miles of wiring are installed.

To provide maximum streamlining, Northrop engineers decided to bury the four P&W engines in the wings with only the prop shafts of the coaxial propellers protruding. And instead of providing each engine with numerous air scoops, "plenum chambers" were devised. Long ducts, one in the leading edge of each side of the wing, take in the air and direct it into the chambers, where the forward motion of the plane builds up pressure. From here the airflow is diverted to feed the two superchargers on each engine, the intercoolers, also the oil coolers. And a large part is directed back over the engines.

Some study of the design as a transport-cargo plane has been made. Company engineers propound the following views regarding such an adaptation: The low-drag high-lift feature is seen enabling the Flying Wing to transport any weight faster, farther, and cheaper than more conventional designs; its simplicity of construction is noteworthy as a one-unit layout; there are advantages of better weight distribution; and spanwise compartmentation would make for ease of loading and unloading.

As against a conventional craft with identical power, gross weight, and fuel capacity these performance characteristics are noted: The Flying Wing could carry one-fourth more useful load, would have one-fourth greater range, and would attain substantially higher speeds.

Development of XB-35

Northrop began independent research on military flying wing aircraft with the N1M (which first flew in 1940), starting preliminary studies of various sizes and arrangements. (See "The Northrop All-Wing," by John K. Northrop, Dec. 1941 Aviation.)

Pioneering all-wing long-range heavy bomber is four-engine pusher with 172-ft. span and 209,000-lb. overload gross weight. First of 15 ordered by AAF, craft embodies novel company-designed control surfaces fitted with special pneumatic loading devices to retain stick feel.

One of early 60 ft. experimental Northrop N9M flying models used to test flying characteristics of all-wing bomber. Starting with N1M, over a dozen of these little craft were built and flown.

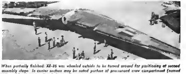
In Sept. '41, Northrop submitted to ATSC preliminary designs providing for extremely long range, high speed, large bomb load, and very high altitude operations. As a result, the company received a contract on a cost-plus-fixed-fee basis, and work was started on several 16 ft. and 18-ft. wind tunnel models which were tested at the plant, and at the NACA's Langley and Moffett Field tunnels.

Warren Knieriem was named project engineer. Other executive engineers closely connected with the XB-35 were W. J. Cerny, Dr. W. R. Sears, and A. M. Schwartz. On July 5, 1942, Wright Field's mockup board inspected a mock-up of the crew nacelle and a portion of the left wing, and fully approved it.

Engineering aid was obtained from the Glenn L. Martin Co. While Northrop engineers had charge of aerodynamic research, basic stress analysis, landing gear, controls and control surfaces, equipment, electrical installations and radio, and armament, the Martin group handled design of the wing structure and power plant installations.

To provide flight research data, Northrop built four 60-ft. flying scale models designated the N9M series. The first three were powered by two 275-hp Menascos. Then the N9M, N9M-A, and N9M-B were constructed, the last named powered by two 300-hp. Franklins.

Fabrication of XB-35 parts began immediately after completion, in Jan. 1943, of Northrop's bomber plant at the east end of Hawthorne Field.



When partially finished, XB-35 was wheeled outside to be turned around for positioning at second assembly stage. In center section may be noted portion of pressurized crew compartment (named 'stinger'), also propeller shaft nacelles.

Piper's new Skysedan is a slim-lined four-placer fitted with a 165 hp Continental 6-cyl engine. Large fore side and rear vision panels of coupe top afford optimum visibility. (Aviation photo)

PIPER'S LOW-WING SKYSEDAN PUT THROUGH PACES

All-metal four-seater, scheduled for mass output early next year, has 165-hp. Continental engine, and retractable landing gear is a feature. New lightweight high-strength wing construction is to be utilized in production version.

LATEST FAMILY SIZE PERSONAL PLANE is Piper's new four-place PA-6 Skysedan, an all-metal low-wing full-cantilever monoplane now undergoing flight trials at Cub Haven Airport, Lock Haven, Pa. It is slated for large scale production early in 1947.

Power plant is a 165-hp. direct drive 6-cyl. Continental E 165-3X, which turns a fixed-pitch wood Sensenich propeller. Since flight testing of the prototype had only just begun, comprehensive performance figures are not yet available, but a top speed of over 150 mph. and a landing speed of about 45 mph. are indicated. Gross weight is put at about 4,000 lb. Two fuel tanks of 20 gal. capacity each are fitted in the wings.

Roominess and good visibility mark the Skysedan's cabin. The front seats are adjustable 4 in. fore and aft. The coupe style canopy allows good headroom, and there is a large transparent panel at the rear. Baggage is stowed beneath each seat. A large door is located to the right of the front seats.

Dual controls are fitted, with the wheel columns going into the dashboard. A lever for actuating the wing-flaps is located on the floor in front of and between the seats, and at the left side is the hand crank for emergency manual actuation of the landing gear. Toe-operated hydraulic brakes are fitted to the left pedals.

Standard instrument panel will include the following: Airspeed indicator, compass, altimeter, tachometer, engine gage, fuel quantity gage, and ammeter. Below this group will be located a switch for navigation and panel lights, parking brake, starter, mixture control, landing gear selector, throttle, ignition, primer, and cabin heat adjustment. A more advanced panel will carry the above plus turn-and-bank indicator, rate of climb indicator, directional gyro, artificial horizon, 8-day clock, and manifold pressure gage (for controllable pitch prop).

Fuselage will be of semi-monocoque construction. On the prototype Skysedan, the wings are of metal construction, fabric covered, with metal-covered ailerons. However, production models will have all-metal wings. Each will consist of five major assemblies—leading edge, top and bottom center skin panels, aileron, trailing edge flap, and wing tip.

Four ribs will be fitted to each main spar, supported by notched chord-wise stiffeners. The top and bottom center panels will be composed of aluminum skin strengthened by transverse stiffeners.

Chosen was landing gear of the inward retracting type, electrically actuated and fitted with Goodrich 7.00 ft tires on Hayes wheels with expanding brakes. The air-oil shock unit used was developed by Piper. A full-swiveling non-retractable tail wheel is fitted.

The tail unit is all-metal, including covering of rudder and elevators. A ground-adjustable trim tab is fitted to the rudder. Noteworthy feature of the tail is the large amount of fin area incorporated to give maximum stability.

North American Testing Navion All-Metal Personal Plane

New craft, priced at $6,100, has specially designed wing for good control at low speeds. Other features are retractable tricycle landing gear and luxurious cabin interior.

MARKING THE DEBUT of North American Aviation into the personal airplane field, the new all-metal Navion is a four-placer with some semblance to the company's famed P-51 Mustang fighter. The craft is now undergoing flight testing to obtain CAA certification. Price has been set at $6,100 F.A.F.

Powered by an 185-hp. aircooled Continental, top speed is estimated at about 160 mph., cruising speed at 150, and maximum range at about 700 mi. Landing speed is stated to be 54 mph., rate of climb (sea level) 830 fpm., and service ceiling 15,600 ft. With flaps at 20 deg., takeoff distance is given as 695 ft., and landing distance (40 deg. flaps) is 905 ft.

With a span of 33 ft. 9 3/16 in., 27 ft. 5 13/16 in. length, and 8 ft. 9 in. height, the craft weighs 1,551 lb. empty, and 2,570 lb. gross. Fuel capacity is given as 40 gal. and baggage capacity as 80 lb.

Of semi-monocoque construction, the fuselage structure is made as a single unit with main structural members being two upper and lower longerons extending aft from the steel sheet firewall. The cockpit enclosure has a clear-vision sliding canopy which can be latched in several open positions. Individual adjustable and upholstered seats are provided for pilot and co-pilot, and the rear double seat has inner spring cushions covered with Air Foam rubber. This back seat is removable to accommodate

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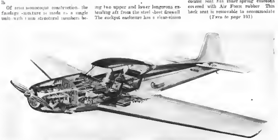
New Continental powered four-place North American Navion exhibits fleet lines in flight. Tagged at $6,100, craft is all-metal, has retractable tricycle gear, and carries good complement of instruments. New wing design is stated to give to give craft unusually fine low speed flight characteristics. Gross weight is 2,570 lb., and top speed is given as 160 mph., range as 700 mi.

Specifications and Data

Span	33 ft. 4 3/16 in.
Length	27 ft. 5 13/16 in.
Height	8 ft. 9 in.
Empty weight	1,551 lb.
Gross weight	2,570 lb.
Fuel capacity	40 gal.
Oil capacity	13 gal.
Baggage	80 lb.
Top speed	160 mph
Cruising speed (5,000 ft.)	150 mph
Most economical speed (51% bhp)	115 mph
Maximum range	700 mi
Rate of climb (sea level)	830 fpm
Landing distance	905 ft.
Takeoff distance	695 ft.
Seating	4
Power plant	185 hp Continental E-185
Price	$6,100 F.A.F.



Phantom view of Navion shows details of engines, instrument and cabin installations. Main landing gear folds into well under rear seats. Engine mount and cowling have been designed to provide easy accessibility, and there appears to be good working space between firewall and cockpit. Horizontal stabilizers are fully interchangeable and entire tail unit can be quickly detached.

Geodetic Structure Featured In Speedy Thalman Special

Wood and fabric one-placer, using war-proven construction, is stated to have a specially wide speed range on 55-hp. Velie engine. Further development of design is contemplated, with a two-seater planned for $2,500 price range.

UTILIZING GEODETIC FABRICATION, the Thalman Special is a new high-performance one-place personal plane now being tested by its designer-builder, Harry J. Thalman, veteran aircraft mechanic of Salt Lake City, Utah. Mr. Thalman plans to evolve two further craft using this basic design, a side-by-sider, and a four-placer.

Outstanding performance is claimed for the prototype, which has been fitted with a 5-cyl. 55 hp. Velie radial engine enclosed in an NACA-type cowl. Weighing but 850 lb. loaded, and carrying a passenger in pick-a-back fashion, the Special is said to climb 1,000 fpm., have a 17,000-ft. service ceiling, and a 125-mph. cruising speed. Top ground speed at 7,000 ft. is given as 156 mph., and landing ground speed as 35 mph. with flaps. A 900 mi. range on 27-gal. fuel capacity is also claimed.

The geodetic "basket weave" structure, used very effectively on the British Vickers Wellington bomber during the war, gives the craft a high safety factor—it is estimated that replacement of the present power plant with a 125-hp. engine would still leave the novel craft with a factor of 6.

Construction is of spruce covered with fabric. The span is 40 ft., and the one-piece wing tapers from 76 in. at the center to 18 in. at the squared tips. The cockpit is fully enclosed and has a canopy that slides forward. Conventional landing gear, with tail wheel, is fitted.

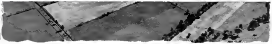
Future Craft

Next model will be a two-seater, now being developed at the Ogden Flying Service shops in Ogden, Utah. This craft is to be powered by an 85 hp. Continental, and is to have an estimated top speed of 165 mph. and a landing speed of less than 40 mph. It will feature a retractable tricycle landing gear and bubble canopy. The elevators will be mounted atop the fin, where it is believed they will be 40% more effective and have 40% less parasitic drag. Estimated price is about $2,500.

The four-placer, which is planned for the 200-mph. class, is to be powered by a 125 hp. engine.

Simple and clean design of Thalman Special is evident in flight view. Of geodetic construction, this prototype is said to have a ground speed range of from 156-mph top to 35 mph landing. (Bob Arentz photos)

Part of "basket weave" structure may be noticed in fuselage below wing. Designer-Builder Thalman states that plane could mount a 125-hp engine and still have a safety factor of 6. Cockpit canopy slides forward.



Lightweight G&A XR-9B Is AAF's Newest 'Copter

Small two-place features simplified control system using conventional stick and throttle to accomplish the cyclic and simultaneous pitch controls. Commercial adaptation of craft is scheduled.

DESIGNED FOR COURIER DUTIES, latest military helicopter is the XR 9B, developed and built by G&A Aircraft, Willow Grove, Pa, in cooperation with ATSC. The company is a subsidiary of Firestone Tire & Rubber Co, and a successor to the Pitcairn organization.

Powered by a 135-hp. 4-cyl Lycoming, the dual control XR 9B is stated to have a top speed of over 100 mph. Fuel capacity is 25 gal. of 80 octane, enough for more than three hours of flight. Preliminary data indicate that cruising speed will be about 80 mph, service ceiling over 10,000 ft, and rate of climb better than 1,000 fpm.

In flight, directional headings are effected by torque correction from the tail rotor through use of rudder pedals. Horizontal flight in any direction is obtained through cyclic pitch control using a conventional control stick. Vertical ascent or descent is made by means of simultaneous pitch control interconnected with manual throttle to assure sufficient power and rotor rpm.

An electric hydraulic governor, acting upon simultaneous pitch control, is stated to maintain constant predetermined rotor speed regardless of throttle condition or power used. Thus, vertical control is effected entirely by using the throttle—the governor providing simultaneous pitch control. A unique rotor head of G&A design is said to virtually eliminate vibration.

Rotor Blade Construction

Main rotor is three-blade using an NACA airfoil. Chord at the root is 15.25 in. and at the tip 8.5 in. Blade surface area is 12.5 sq. ft. Two blade tail rotor, also using an NACA section, has a 6 ft. 6 in. dia, with chord measuring 6½ in. at the root and 3.8 in. at the tip. Blade area is 1.125 sq. ft.

Rotor blades are made of step-tapered heat-treated steel tube spars to which 7/32-in. five-ply poplar plywood ribs are attached by stainless steel collars.

New G&A XR-9B courier copter hovers during trials at Wright Field. Landing gear is fixed tricycle and there is a skid at the tail to protect the anti-torque rotor. A top speed of over 100 mph, is claimed, using a 135 hp. Lycoming engine.

Leading edge strips are spruce over the inboard half of the blade and maple over the outboard half, and they have lead ballast imbedded. Trailing edges are of spruce. Top and bottom surfaces of the framework are covered with 1/32-in. three-ply mahogany with poplar core. Blades are fabric covered and doped.

The fuselage is made-up welded steel tubing, covered with aluminum alloy, and there is a large Lucite nose section for maximum visibility. The high-mounted boom has a balsa core with an Alclad skin covering. Only eight instruments are mounted on the simplified instrument panel.

Ease of disassembly for shipment or storage is noted. The tail section can be detached by removing six bolts and two control wires. Rotor blades are removed by taking out three bolts and three pins and by unseating three ball and socket joints. Two removable panels on each side of the fuselage provide access to the engine and transmission, and three panels in the boom aid maintenance and inspection work there.

Planning has already proceeded with a view to postwar commercial possibilities of the XR-9B, it being stated that the commercial prototype was due to be completed about the time this article went to press. It is indicated that this civil version features a larger cabin.

All-metal Avro Tudor 2 is new 40-60 passenger long-range airliner with a 34-ton gross weight. A number are slated for use by BOAC. (Wide World photo)

BRITISH PROVING THREE DIVERSE NEW CRAFT

Avro, Reid & Sigrist, and Fairey company planes are being test flown as civil and military replacements. Tudor 2 is Britain's largest airliner, Desford is cleaned-up wartime trainer for civilian use, and Firefly is speedy Merlin-powered Royal Navy fighter.

Two new civil and one military craft have made their appearance in Britain. These are the 40-60 passenger Avro Tudor 2 airliner, the Reid & Sigrist Desford twin-engine trainer, and the Fairey Firefly F Mk 4 carrier fighter.

Powered by four 1,770-hp. Rolls-Royce Merlins, the Tudor 2 has a span of 120 ft., 105 ft. 7 in. length, and 24 ft 3 in. height. The 60-passenger version has an estimated 1,850-mi. range at 230 mph. at 20,000 ft., while the 40-placer is designed for a 2,450-mi. range at 230 mph at 20,000 ft. Used as a freighter, it is figured that nine tons of cargo could be carried for 1,100 mi. at 200 mph. at 10,000 ft.

Large-scale production has already started, and it is planned to have 40-50 Tudor 2s finished by the end of this year. Others are to be built in the Australian Government's Melbourne plant and by A. V. Roe, Ltd., Canada.

The Reid & Sigrist Desford is powered by two 130-hp. DH Gipsy Major I 4-cyl inverted engines. A development of the wartime Snargasher primary trainer for twin-engine pilots, the main differences in the newer model are lighter weight and a cleaned-up cockpit with a one-piece transparent sliding canopy.

Being produced as a standard Royal Navy carrier-based two-place fighter, The Fairey Firefly F Mk 4 is the latest modification of a type that saw action against the Japs. The prototype, fitted with a 2,300-hp Rolls-Royce Griffon 72, is stated to have a 386-mph. top speed at 14,000 ft. Production models will have 2,245-hp. Griffon 74s.

Fairey Firefly F Mk. 4 two-place naval fighter is stated to have 386 mph. top speed. Note radome under right wing. (Aeroplane photo from British Combine)

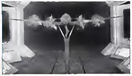
Reid & Sigrist Desford two-place twin-engine trainer with fixed landing gear is designed for use by flying schools. Large clear-view canopy is noteworthy. (British Combine photo)

PREFLIGHT TESTING SHOWED "CONNIES" ROYAL BLOOD BEFORE SHE EVER LEFT THE GROUND!

MONTHS OF ARMY SERVICE PROVED IT!

CONTROL BOARD—On this master control board, Lockheed experimental engineers watch every phase of "Connie's" preflight testing.

VIBRATION TEST—To check the sturdiness of "Connie's" 3,500 lb. wing, it was shaken for hundreds of hours—subjected to test loads up to 50 tons.



WIND TUNNEL TEST—A 9-foot wing span model of "Connie" helped designers to predict her flight characteristics before she ever left the ground.

LAB SHIP—The Constellation's engineering developments were subjected to exhausting tests in lab ships before they were installed.

LOW TEMPERATURE TEST—To make certain "Connie's" operating units would perform in searing heat or Arctic cold, they were first tested in this temperature chamber.

HYDRAULIC FATIGUE TESTS—Full scale mockup simulated the most drastic flight conditions. "Connie's" hydraulic system was tested and tested again.

"CONNIE" IN THE AIR FORCES—"Connie" established new standards of dependable performance and economical operation in her three years with the Army Air Transport Command. Taking off and landing all over the world, on lighter, stronger U. S. Royal Airplane Tires, she performed vigorous service faster and better than ever before.

"CONNIE" IN AIR LINE SERVICE—Flying for many of the world's great airlines, "Connie" is now breaking speed and performance records on commercial airline routes everywhere. Blending speed and luxury with range to span oceans, Lockheed Constellations are tying cities and nations closer together—shrinking barriers of time and distance.

UNITED STATES RUBBER COMPANY

6600 East Jefferson Ave., Detroit 32, Michigan
5675 East Anaheim Telegraph Rd., Los Angeles 22, Calif.

Induction, R. F., and Dielectric Heating Formulas

Induction Heating Formulas

DEPTH OF CURRENT PENETRATION IN A NON-MAGNETIC CONDUCTOR

$$\delta = 1.98\sqrt{\frac{\rho}{f}} \text{ (inches)}$$

δ = depth of current penetration
ρ = resistivity of work micro-ohms-cms
f = frequency in cy/sec

DEPTH OF CURRENT PENETRATION IN MAGNETIC CONDUCTOR

$$\delta = 1.98\sqrt{\frac{H_o\rho}{Bf}} \text{ (inches)}$$

δ = depth of current penetration
H_o = peak magnetizing force (oersteds).
ρ = resistivity of material in micro-ohms-cms.
f = frequency in cy/sec.
B = flux density in material—gauss (usually assumed as 16,000).

R. F. Heating Formulas

RADIATION AND CONVECTION LOSS FROM SURFACE (THERMAL LOSSES)

$$W_r = 37e\left[\left(\frac{T_1}{1000}\right)^4 - \left(\frac{T_2}{1000}\right)^4\right] \text{ watts/sq in}$$

W_c = .001 $\theta^{4/3}$ watts/sq/in
T = 5/9 F + 255.4.
F = degrees Fahrenheit.
θ = 5/9 Δ F
e = relative emissivity = 1 for black body radiation

INDUCTIVE REACTANCE

X = $2\pi f$L ohms
X = inductive reactance (ohms)
f = frequency cy/sec
L = inductance in henries.

Dielectric Heating Formulas

VOLTAGE GRADIENT IN ANY DIELECTRIC LAYER IN PARALLEL PLATE CAPACITOR WITH PARALLEL LAYERS OF DIFFERENT DIELECTRICS

$$E_i = \frac{E \times 10^{-3}}{e'_k\left[\frac{a_1}{e'_1} + \frac{a_2}{e'_2} + \cdots + \frac{a_n}{e'_n}\right]} \text{Kv/in.}$$

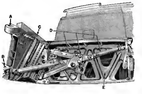
E_i = voltage gradient (Kv/in.) of layer considered.
E = total electrode voltage (volts)
e'_k = dielectric constant of dielectric layer considered.
a_1 = thickness of first dielectric layer (inches)
a_2 = thickness of second dielectric layer (inches)
a_n = thickness of n th dielectric layer (inches)
e'_1 = dielectric constant of first dielectric layer.
e'_2 = dielectric constant of second dielectric layer
e'_n = dielectric constant of n th dielectric layer

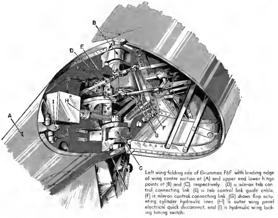
CAPACITY OF PARALLEL PLATE CAPACITOR WITH PARALLEL LAYERS OF DIFFERENT DIELECTRICS

$$C = \frac{224A \times 10^{-15}}{\left[\frac{a_1}{e'_1} + \frac{a_2}{e'_2} + \cdots + \frac{a_n}{e'_n}\right]} \text{farads}$$

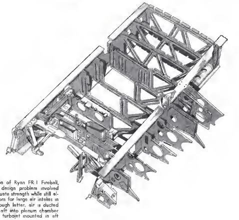
C = capacity (farads)
A = electrode area (sq in.)
a_1 = thickness of first layer of dielectric (inches)
a_2 = thickness of second layer of dielectric (inches)
a_n = thickness of n th layer of dielectric (inches)
e'_1 = dielectric constant of first dielectric layer
e'_2 = dielectric constant of second dielectric layer
e'_n = dielectric constant of n th dielectric layer

Outboard end of Grumman F6F Hellcat wing center section structure, showing wing folding hinge fittings (A) and (B) bolted to front spar (C), also builtup landing gear support structure (D) and typical rib (E).

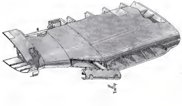




Left wing folding axis of Grumman F6F with leading edge of wing center section at (A) and upper and lower hinge points at (B) and (C), respectively. (D) is aileron tab control connecting link. (E) is tab control link guide cable, (F) is aileron control connecting link. (G) shows flap actuating cylinder hydraulic lines. (H) is outer wing panel electrical quick disconnect, and (I) is hydraulic wing locking timing switch.

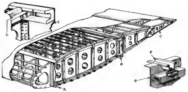


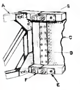
Center wing section of Ryan FR-1 Fireball, in which principal design problem involved attainment of adequate strength while still allowing sufficient room for large air intakes in leading edge. Through latter, air is ducted under cockpit and aft into plenum chamber ahead of GE I-16 turbojet mounted in aft fuselage.

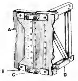


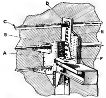
Section of right wing of Ryan FR-1, depicting air intake for turbojet. Just to left of intake, leading edge skin has been removed to show installation of two of craft's four 50-cal. machine guns.

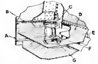
Typical section through Lancaster wing, with front spar at (A) rear spar at (B) and aileron rib at (C) Method of attaching rib (D) to spar (E) is shown in detail sketch at upper left attachment of stringer (F) to rib (G) is shown in detail at lower right.

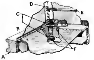












Sketch at upper left shows details of Lancaster rear spar center section-to-outer panel joint with engine rib (A) boom joint pin (B), outer panel spar web (C) web joint plate (D) reinforcing plate (E) and steel shackle (F) Top center sketch is of same area looking forward with outer panel web (A) reinforcing plate (B) shackle (C) and engine rib (D) Upper right sketch shows connection of rear spar upper boom to fuselage with stringer brackets (A) gusset plate (B) stringer (C) stringer attachment angle (D), web joint plate (E) shoe bracket (F), and spar boom (G) Lower left sketch gives details of rear spar bottom boom-to-fuselage joint, looking aft. Fuselage longeron is at (A) strap plate at (B) corner bracket at (C) floor top at (D) spar boom at (E), packing block (F), and corner bracket at (G) Lower right sketch gives details looking forward, with spar boom (A) floor top (B) corner brackets (C) stringer attachment angle (D), and stringer (E). Longeron has been cut away at (F) for clarity.

By ELTON H. BROWN, JR.

Registered Patent Agent

Following are digests of some of the more interesting patents on aviation developments granted by the U S Patent Office Mr Brown will be happy to answer questions on patents for the reader Address inquiries to him, care AVIATION, 330 West 42nd St, New York 18, N Y Printed copies of any patents listed are obtainable at a cost of 10c each, directly from U S Patent Office, Washington, D C

Fuel Container for use in aircraft wings is constructed of flexible material and is bolted in wing so as to be easily removable for inspection cleaning or replacement. Special type of reinforcing grommet in flexible material is used to receive bolts—2,397,184, filed Oct. 31, '40 pat. Mar 26, '46, A J Kiose assignor to Consolidated Vultee Aircraft Corp

Airplane Spray Unit for uniformly applying insecticides to crops is operated by self-contained propeller Readily detachable equipment has been approved by CAA and is licensed for NC aircraft.—2,396,827 filed July 2 '45, pat Mar 5, 46, C N Husman et al, assignors to U S Government (represented by Secy of Agriculture).

Control Means for airfoils which require force multiplication to assist pilot in operation of same locks airfoil in each position of movement until pilot actuates manual control Plurality of power sources is provided for contingency of primary power source failure.—2,345,671 filed Sept. 66 '46 pat Feb 26 '46 E S. Kleinhans et al, assignor to Douglas Aircraft Co

Aircraft Interior Design, intended for combined or convertible passenger-freight service, provides for seats folded into wall or ceiling recesses during freight operation, with quick conversion to usable position when change to passenger service is desired—2,396,030, filed Nov 10, '41, pat Mar 5 '46, E F Burton et al, assignors to Douglas Aircraft Co.

Airship of power-driven non-rigid type incorporating girder construction to support load force eliminates internal suspension cables and has girder structure sufficiently yieldable for adjustment to changing shape of gas bag—2,396,494, filed July 16 '41, pat Mar 12, 46 L. R Donnell et al, assignors to Wingfoot Corp

Cowling for aircooled engines, designed to cooperate with adjustable fairing mounted on propeller shaft, acts as valve to vary cooling air flow to power plant.—2,396,598 filed Jan 8, 41, pat Mar 12, '46, H. Newmann et al, vested in Alien Property Custodian.

Aircraft Structure of stressed skin design embodies improved shape and construction of spars and ribs to facilitate welding operations and assembly of parts, achieving weight reduction without sacrificing durability strength or rigidity—2,396,624, filed Mar 26 '41 pat Mar 12 '46 M. Watter, assignor to Edward G Budd Mfg Co.

Airplane of type used on aircraft carriers, has tricycle landing gear and utilizes arresting hook operating on telescoping principle Hook mechanism is further improved by using positive-acting combination gear and lever system—2,396,028, filed Nov 1 '41, pat Mar 12, '46 R. J Woods, assignor to Bell Aircraft Corp

Multi-Engine Drive Mechanism, designed for adjustable propeller features gearing for connecting plurality of power plants to single hollow shaft propeller via coupling means adapted to become inoperative when torque becomes negative Auxiliary shaft coaxial in and coupled to hollow propeller shaft is angularly displaced with relation to latter means being incorporated to change blade pitch in accordance with angular displacement.—2,396,745, filed Nov 4 '39 pat Mar 19 '46 F Nallinger et al, vested in Alien Property Custodian.

Cooling Fan Installation for high-hp radial aircraft engine featuring a multi-bladed blower coaxially arranged with propeller shaft and gear driven by latter at twice its speed is intended to increase cooling air flow without basic change in engine or cowling design—2,396,282, filed Jan 20 '40, pat. Mar 12 '46, A Chilton assignor to Wright Aeronautical Corp

Shock Absorbing Strut for aircraft uses combination of hydraulic and gas cushioning Hydraulic medium operates upon trapped air pocket, and cushioning effect is transmitted through latter Metered openings are provided to permit slow passage of the hydraulic fluid from one chamber to another—2,396,216, filed Nov 18 '42, pat Mar 12 '46 O W De Bell, assignor to Reconstruction Finance Corp

New Propeller features fin on blade tip portion to reduce noise and nullify tip loss by causing centripetal movement of air adjacent to tip—2,396,311 filed Dec 10, '42, pat Mar 12 '46 J E Bathrox.

Recent Books

THE AVIATION ANNUAL OF 1946, by Reginald M Cleveland and Frederick P Graham Doubleday & Co, Garden City, N Y. 245 pages illustrated. $4 00.

Roundup of wartime aviation with sectional forewords by Army, Navy, airline manufacturing and governmental officials Also included in this popular annual are sections devoted to aviation education and the outlook for the future

ELEMENTS OF AMMUNITION, by Maj Theodore C Ohart John Wiley & Sons New York City 412 pages. Drawings, photos, index $6 00

Written for the beginner in ammunition design and development work, one 66-page section of this volume is devoted to aircraft ammunition, covering design specifications and nomenclature of various types of bombs and their components

ELEMENTARY APPLIED AERODYNAMICS by Paul E Hemke Prentice Hall, Inc New York City 231 pages, diagrams, charts, index $3 25

This book has been written to meet the requirements of a first course in technical applied aerodynamics, and included with the fundamentals are certain topics generally found in more advanced courses Among the latter is a treatment of the stream function of an ideal fluid flow Also presented are a short chapter on compressibility effects and an introductory chapter on rotors and helicopters Treatment is simple and direct throughout

MACHINE TOOL WORK, by W P. Turner, revised by H F Owen McGraw Hill Book Co N Y C 364 pages, photos, index $3 00

This new second edition covers as before, the fundamental problems common to all kinds of machine-tool work including the lathe planer shaper milling machine drilling machine, and grinding machine New features include a chapter on shop safety and a chapter on broaching Moreover material has been added to the chapter on grinding A chapter on measurement has been compiled from material presented in the first edition Problems have been gathered at the end of the book

GUY GILPATRIC'S FLYING STORIES E P Dutton & Co, Inc, N. Y. C 287 pages $2 50

This latest collection of stories by the well-known fiction writer presents a dramatic, fictionalized history of 40 yr of aviation progress Well written and entertaining these yarns will be appreciated for the background of factual material on which the stories are based

THE DIME NOVEL CLUB Facsimile Reprint Folder Charles Bragin, The Dime Novel Club, Brooklyn, N Y $2.00

This folder contains reprints in facsimile of the famous quaintly illustrated series of boys aviation adventure narratives by Noname whose real name was Lu Senarens Written over 60 yr ago they retain their attraction for the collector and for those in the industry who like to explore early prophetic aviation writings

THE CASE AGAINST THE ADMIRALS, Why We Must Have a Unified Command, by William Bradford Huie E P Dutton & Co New York City 216 pages, index $2 50

Mr Huie who earlier authored "The Fight for Air Power," here advances arguments against what he targets as reactionary naval viewpoints With considerable force in his manner of presentation he discusses alleged faults of the naval air power criterion which obtained early in the war and previous to it, the Pearl Harbor case being specifically cited With conclusions drawn in favor of a single air command, the book refutes the biases of differences between those advocating all-out independent air power and those who hold to the more conventional lines of military thought

INDUSTRY PUBLICATIONS

New booklet, "Civilian Wings for Everyone", offered by Shell Oil provides introduction to flight and gives information on obtaining a pilot's certificate ... UAL report, "You Told Us What You Wanted in Your Half-Million Dollar Postwar Mainliner" is study based on 3,000,000 answers from 19,000 airline patrons who specified features they desired most ... "Birds of a Feather" is Schweizer Aircraft Corp's new booklet dealing with soaring Included is map of gliding sites. For copy address company at County Airport, Elmira N Y ... Charts showing exact location and elevation of all obstructions around principal U S airports are now available from Coast & Geodetic Survey, Washington, D C at 49¢ each ... "Realm of Flight" and "Path of Flight" are new CAA publications available from Government Printing Office, Washington, D C., at 60¢ and 45¢ respectively Former deals with weather knowledge while latter is simplified avigation manual ... "Air Transport of Agricultural Perishables", is detailed analysis of costs and methods available from U S Dept of Agriculture ... "Aeronca's Proposal for Formation of Light Plane Flying Clubs", is new publication offered by that company to explain club procedures. Information on financing insurance and club code regulations is included ... "A Pictorial Report by United Aircraft" is company's well-illustrated account of achievements current activities and future plans.

COULD IT BE THAT brass hats are the same, whether they are service or civilian? Seems they are, as shown by the following story just reported by one of the country's best feminine engineers.

The brass of a big company decided they would like to inspect, *en masse*, their bright, shiny new wind tunnel at 2 P.M., Thursday. According to standard practice, they advised the tunnel staff of their impending arrival at 1 P.M., that same Thursday. Frantic hiding of coke bottles, lunch sacks, and stray cigaret butts made the place look better, but didn't alter the fact that the sparkling model was not installed and ready for test. Somehow they did get the model in the tunnel by 2 P.M., but the 48 manometer taps were still unconnected. And, because the tunnel was so very new, the balance was not yet working.

Then, like death and taxes, the brass hats arrived—on time for once—and wanted to see their tunnel in operation and so the director directed that a test be run. The wind was turned on with impressive noise, and comely engineering aides sat with pencils poised to record the data. Rising to the situation the engineer at the board began reading in a sepulchral voice, "One, zero. Two, oh point oh. Three, nothing point zero zero. Four point oh oh oh."

Sensing the board man's desperation, the engineer in charge then abruptly stopped the test—and the brass, too—by crying out: "Configuration—L-S, M-F-T!"

Anent the great bugeeoss
Of Hughes' flying boat,
That first takeoff
May turn sponsors gray.

We arise to advise
A way safer by far—
Set 'er out and
Move Ma Earth away!

• Our spring season has been greatly lightened by receipt from a Latin American aeronautical concern of a New Year's greeting card. Postmarked at 11:30 P.M. Dec. 31, 1945, it took just a shade over four months to get here. Whereupon the little philatelist looking over our shoulder said, "Gimme the stamp, bub, that one must have come airmail."

• The hangar-flying session got around to instrument flying, whereupon one participant reported he knew a guy who could spell his name with a Link Trainer. "And if you think that's easy," he added, "try writing 'Larry Schmidlapp' under a hood. But I bet if you could get him a big enough map he'd do the address, too—Cincinnati."

• Just heard of a small airport that last year derived more revenue from the washroom coin slots than from its airplane services.

Well, a profit's a profit, no matter where it comes from, but we can't help wondering if the field restaurant wasn't in on the deal—you know, a small shot of croton oil in each cup of coffee. To which the guy looking over our shoulder mutters, "some airport coffee I've had certainly tasted like it had that little added ingredient."

• Comes now a beautiful architectural dream for the airport to end all conventional airports, for this one has everything—including plans which state that "buses and trucks can be serviced by the same mechanic who is available for the planes."

Better be a little cautious there, planners. Are you sure buses and trucks can be trusted with a guy who's only worked long and hard enough to be an A & E mechanic?

"Maguire's put in for a transfer before they start blowing any more atom bombs UP, he wants to be way, way DOWN."

THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York E. J. BULBAN, New York

Strategic, Tactical, and Defense Commands Established in AAF Re-Organization Move

Final action on unification may await atom tests . . . Report "Frostbite" data . . . Airport bill speeded . . 20,000 surplus craft sold . . . Surplus planes to CAA . . . Spark personal flying . . . Policy staff now at work . . . Field inspectors added . . . "Mach's Package" for vets . . . Would "aviationize" mail

Re-organization of the AAF to bulwark the U S against air attack sets up (1) A Strategic Air Command under Gen George C Kenney; (2) a Tactical Air Command under Maj Gen E R Quesada; and (3) an Air Defense Command at Mitchel Field N Y, headed by Lt Gen George D Stratemeyer Gen Harold L. George, who is being succeeded by another man as chief of the Air Transport Command, heads up a new program of Air Force public relations.

AAF Commander Gen Spaatz in announcing his reorganization told of plans for an important Air Reserve and Air National Guard He has set Jan 1 1947 for completion of whatever U S air strength is authorized by Congress

The following five supporting commands are established under AAF headquarters Air Materiel at Wright Field Lt Gen Nathan F Twining; Training Command Barksdale Field La., Lt Gen John K. Cannon Air Transport Command Washington; Air University, Maxwell Field, Ala., Maj Gen Muir S Fairchild

Gen Spaatz said that the 16 air forces (1st through 15th plus the 20th) will be maintained and assigned to combat commands or schools Mission of AAF he said is to develop and maintain a military air force capable of immediate, sustained and expanding application of the accepted American doctrine of military air power

Final Action on Unification May Await Atom Tests

Senate Committee on Military Affairs was due at this writing to receive a favorable report from its subcommittee on unification of the Army, Navy, and Air Forces under a single Cabinet officer for Defense with co-equal status for the Air Forces. It was believed that the main committee would report within a week or two—much sooner than expected Hearings by House Committee on Expenditures in Executive Departments were scheduled to start in April Final action by House and Senate, and signature by the President, probably will not be forthcoming until after the atomic bomb tests

Report "Frostbite" Data

Navy's 40,000-ton carrier Midway returned from its Operation Frostbite in sub-Arctic Greenland waters, where it cruised in low-temperature weather Task Force Comdr John H Cassidy reported the Vought Corsairs Curtiss Helldivers and Grumman Hellcats were operable about 90% of the time Gasoline mixed with oil made for easy engine starting Radar was excellent for spotting large icebergs. Experience indicated most warships can work in northern waters

Airport Bill Speeded

After perennial controversy, the federal-aid airport bill is out of conference committee in Congress, and early agreement between the House and Senate and signature by the President is expected Bill provides for 3 000 new airports over a period of 7 yr The Federal Government won over the States in the tussle for control of funds, which makes for co-ordination in development of the nation's airport system, but will result in continuous wire pulling at Washington

Fact that 700 to 800 military surplus airports are available received inadequate discussion, but these are mostly of the large air-terminal type, while most of the federal-aid fields will be smaller

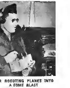
20,000 Surplus Craft Sold

The government has sold well over 20 000 surplus airplanes of all types, with 3,392 going to buyers in January and February This includes 5 376 sold by CAA at conclusion of War Training Service. Largest sales are liaison, primary, basic and advance trainers, utility cargo, and light transport. Latest sales leader is Fairchild PT-23 at $590 to $1,275, depending on condition with but 700 of these craft remaining in surplus stock Prices of twin-engined Cessnas have been adjusted downward to the $3,-500-to-$2 400 range lower prices being for those equipped with wood propellers and lighter wings for smaller load, and depending on condition of craft

Surplus Planes to CAA

CAA obtained 230 war surplus planes for its official transportation, replacing obsolete planes in its possession And seen was a saving to the taxpayers of $6,000 000 over a 5-yr period.

When CAA announced it would acquire a stock of surplus parts and do its own installation and reconditioning at its own stations protests arose from various aircraft service groups (also see story on page 81) At press time it was suggested that a compro-



FOR ROBOTING PLANES INTO A BOMB BLAST

Theo J Wilson, Minneapolis-Honeywell Regulator Co tech rep assigned to Operations Crossroad demonstrates remote control box by which four planes will be directed from mother plane over Bikini Atoll during atom bomb test M-H electronic autopilots have been modified to receive signals by radio with control being transferred, after takeoff, to command plane Latter will be some miles from blast. (AAF photo)

COMING UP

- May 6-7: AIA National Aircraft Standards Committee 11th National Meeting, Hotel Lexington N Y C
- May 6 8 AIA & CAA First Joint Engineering Conference Shoreham Hotel Washington D C
- May 7 9 National Assn of Corrosion Engineers, Annual Meeting and Convention President Hotel, Kansas City Mo
- May 10 NAA Directors Meeting Statler Hotel Washington D C.
- May 13-14: New York State Aviation Council Semi-Annual Meeting, Westchester Country Club Rye N Y
- May 20 22 American Assn. of Airport Executives Annual Convention Congress Hotel Chicago.
- May 21 PICAO Assembly begins 6-wk meeting at Montreal
- May 24 Kansas Farmer's Flying Club Convention & Exhibit, Hutchinson Kan.
- May 27 28 Aeronautical Training Society Annual Meeting Mayflower Hotel Washington D C.
- June 1-2 National Air Carnival, Birmingham
- June 2 7 SAE Summer (Semi-Annual) Meeting French Lick, Ind.
- June 3 5: ASME 1946 Aviation Meeting (sponsored by Aviation Div) Los Angeles Campus of University of Calif
- June 8 9 Formal dedication of Eldon Mo , model airpark.
- June 12 15 International Air Show DeHavilland Airport, Toronto (sponsored by National Aeronautical Association of Canada) NAAC Third National Air Conference will be held concurrently (June 14-15) King Edward Hotel Toronto, Ont.
- June 13 14 IAS Light Aircraft Meeting, Rackham Educational Memorial Detroit
- June 13 15 First Postwar Annual New England Lightplane Tour
- June 24 28 American Institute of Electrical Engineers 1946 Summer Convention Statler Hotel, Detroit
- July 18-21 World's Fair for Aviation, Omaha.
- July 19 20 NAA National Convention Omaha Neb
- Aug 1 2 The National Flying Farmers Assn First Annual Convention & Oklahoma Flying Farmers Conference, Oklahoma A & M College Stillwater, Okla.
- Aug 15-16 IAS Annual Summer Meeting Los Angeles.
- Aug 22-24 SAE National West Coast Transportation & Maintenance Meeting New Washington Hotel Seattle.
- Aug 31 Sept 2 National Air Races Cleveland
- Oct 3 5 SAE National Aeronautic Meeting & Aircraft Engineering Display Biltmore Hotel Los Angeles
- Oct. 14 17: National Aviation Clinic Oklahoma City
- Oct 16 17 SAE National Transportation & Maintenance Meeting, Hotel Knickerbocker Chicago
- Oct. 23 25: Second Annual Arizona Aviation Conference, Phoenix
- Oct. 24 IAS Air Transport Meeting Statler Hotel, Washington D C
- Oct. 29 IATA Annual Meeting, Cairo.
- Nov 7-8 SAE National Fuels & Lubricants Meeting, Mayo Hotel Tulsa
- Dec. 2 4 SAE National Air Transport Engineering Meeting Edgewater Beach Hotel Chicago
- Dec 17 IAS Wright Brothers Lecture, N Y C

mise might become possible through U. S. General Accounting Office whereby CAA might contract for the maintenance work, rather than call for bids on each job

Spark Personal Flying

Eight private aviation experts, composing CAA's new Private Flying Specialists group, recently initiated plans at Washington for aggressive promotion of personal flying Administrator T. P. Wright, receiving their suggestions, gave his own opinion that more airports, better education and training, simpler regulations and above all "an improved private flyers plane," are essential to full growth of personal flying

Policy Staff Now at Work

A Plans & Performance Staff has been set up to work with the office of T. P. Wright, CAA Administrator. This body is to make studies on broad policy matters and develop recommendations for long-range programs, handle CAA liaison work on the Air Coordinating Committee and PICAO, also the coordination of engineering and standardization work involved in CAA's relationships with public and private organizations

Field Inspectors Added

With appointment thus far of approximately 100 mechanics as aircraft maintenance inspectors and with 160 recommendations pending, CAA expects to have competent inspection personnel available at the principal flying centers, thus reducing maintenance problems of private plane owners. Eventually, CAA plans to have a designated examiner at several hundred conveniently located fields all over the country

"Mech's Package" for Vets

Ex-servicemen interested in aircraft and engine licenses may obtain without charge a new "mechanics information package" which details license requirements, lists what the GI Bill of Rights affords in connection with on-the-job and school mechanic training, and lists approved mechanic schools. Included are two booklets "Aviation Jobs for Veterans" and "Employment Outlook in Civil Aviation". Package is available from the Office of Aviation Information, Civil Aeronautics Association, Washington, D. C

Would "Aviationize" Mail

Air carriage of long-haul first-class mail increasing the revenues of carriers by $81,000 000 per year, is proposed by Gael Sullivan Second Assistant Postmaster General, in a report to PMG Hannegan. It was stated that eventual "aviationizing" of all first-class mail on hauls exceeding 300 mi, at 3c per oz, would improve the mail service employ ex-service airmen, and build a large military aviation reserve.

Immediate proposal is to reduce airmail rate from 8c to 5c Initial Post Office deficit resulting from expanded mail program would be more than offset in public benefit, Sullivan says Present ton-mile mail rate is 53c which is higher than the passenger and express rates. Future rate for mail must be reduced to about 32c which was proposed by CAB in 1934

Reciprocal arrangements with foreign countries to reduce the airmail rates are also proposed. Another report on the detail of costs and the use of other transportation will be issued about July 1

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

CAA has called a halt on special inquiries concerning aircraft registration and ownership certificates because it has a backlog of 10 000 applications Yet a Congressional Committee has cut $74 000 000 from CAA's budget, contending it has "one employee for every three planes certificated" You can join either side of the controversy—it's free for all

Until purchase and maintenance costs of light planes are considerably reduced, club flying will go on gaining in popularity for club managers are claiming important economies per flying hour

The Stubblefield Award goes to the Air Materiel Command which flew a Boeing B-17 around the world looking for the worst thunderstorm—and then found it in Missouri

Executive order authorizing CAA to maintain 200 war-built avigation facilities in 68 foreign countries is an important move toward maintenance of U S. air commerce and air power

Reflecting growing public opinion, CAB in its decision on Rocky Mountain and Florida cases extending service to many hither-to unserved communities, and the Post Office in its recommendation that airmail be "aviationized," both reverse their former policies and move toward shortline expansion Effect of Rep Jennings Randolph's resolution, though not passed, was important

Hopes for atomic power in aircraft in the foreseeable future are mostly delusions Present technique puts the heft of such plants at scores of tons per unit. However, atom power for stationary and maritime plants does seem feasible It could be a boon for submarines because it needs no air

Shipping companies battle strenuously for air certificates becoming increasingly apprehensive that aviation will take most of their passengers They rush forward and argue that U S bilateral agreements are giving air routes to foreign maritime interests competing against our shipping No easy answer is apparent. Whether you like it or not don t bet against the ship-rail combination to win a compromise in the end

RESEARCH ROCKET CLIMBS 43½ MI

This new Douglas-built Caltech developed rocket reached 230 000 ft altitude carrying scientific instruments for U S Army It is stated that new rocket is not a weapon but a research instrument designed to explore upper atmosphere and ionosphere in order to gather data on wind velocities temperatures, gravity pull and aerodynamic drag Power is obtained from a liquid propellent, combining fuel and oxidizer and rocket has three tail stabilizing fins Rocket, named "WAC Corporal", is made of steel aluminum and magnesium. Length is 16 ft., dia is 12 in.

★ SPOT CHECKING ★

Azon 1,000-lb radio-controlled bomb used with great success near war's end After missile is released, a 2,000,000-cp flare in tail ignites, and bombardier can visually trace bomb's path toward objective, operating a control stick to steer it into target It is claimed that errors of as little as 5-10 ft can be noted and then corrected from heights of up to 15 000 ft. Development was carried out by Gulf Research & Development Co under OSRD and AAF

Joint project to demonstrate use of small planes in crop dusting is being undertaken by Tenn Bureau of Aero and Tenn. Agricultural Extension Service Track will be kept of crop dusting costs so that data can be supplied to plane operators and farmers

CAA now permits distributors to test-fly new planes manufactured under type certificates Procedure obviates need for maker to assemble planes for test and disassemble them for shipment Personal pilots are again permitted to file flight plans with CAA's network assuring search procedures should pilot fail to arrive at destination on schedule

AAF is testing Lockheed XF?-5?A a photo-recon version of Shooting Star fighter Plane is fitted with a new view finder which insures accuracy of camera sighting

Study of atomic possibilities in aviation is planned as subject of a large scale research program to be initiated at NACA's aircraft engine research lab. at Cleveland Final constitution of the National Atomic Board is awaited before going ahead

Two airborne television systems, coded Block and Ring, are revealed by U S. Navy Larger Ring system can transmit high-quality pictures up to 200 mi from 12,000 ft up Smaller Block transmitter more compact and with shorter range was used during war to guide

pilotless missiles to targets Developmental devices was carried out by RCA and NBC in cooperation with Navy.

Federal reformatory at Chillicothe, Ohio, received CAA approval for its aircraft and aircraft engine school which, during war, furnished mechanics to various AAF maintenance depots and war plants Graduates, like CAA examinations, are issued mechanics certificates upon release

Progress in aircraft speeds in connection with possibility of entirely new conceptions of time elements is subject of detailed study by Academy of Time, which has made grants to a number of universities for special studies of this new field. Some of questions posed by Academy are: Will there be an Air Time to succeed Greenwich Mean Time? What effect will 24-hour day produce on time-pieces be succeeded by 24-hr clocks and watches

During further ATC tests on Fairchild C-82 Packet, craft was loaded with 8870 lb of general freight and flown from Pa to Panama City. Significant was fact that loading cargo took but a man-hours and unloading but a man hours.

From Newark, three Bendix demonstration planes headed out on nation-wide tour to conduct public tests of company's new VHF air ground radio system for personal craft. Known as PATR-20 Flightphone, unit weighs 7 lb, including built-in power supply, shock mount and range finder Production is stated to begin next month.

To test maximum speed at which Lockheed P-80 can be safely flown, a pilot-less remotely controlled Shooting Star will be put through a series of power dives over Muroc Army Air Field Cal. Mother plane will be a second P-80.

Unique news service named Parasnews has been formed on West Coast by ex paratrooper Mike Watson Company offers to parachute its newsman-photographers into otherwise inaccessible spots as arrive in time specified and newspaper charges. Address is 1817 Madison Ave., Pasadena 6 Cal.

* CALLING NAMES *

Russell Weatherwax, Gordon Wall, and Raymond Sirens have been elected Aeronca directors.

Howard E. Weinscott has been appointed chief inspector of Beech.

John F. Budd, of Northeast Airlines has been named director of public relations for Airlines Club of N Y

Paul W Zimbrook is Sinclair Refining Co.'s new mgr of domestic lubricating oil sales

F Trubee Davison has been elected pres of Air Power League succeeding Charles E Wilson, who was named board chairman

Operations committee of ATA has appointed William E. Becker as CAB specialist H L Roberts in air traffic control and Martin A Wereskey to airport and approach lighting

Brig Gen Lawrence J Carr has been elected board chairman of Trans-Caribbean Air Cargo Lines

Thomas Wells resigned his position as WAL v-p in charge of traffic in order to continue research and special aviation writing

Melvin J Sloss, formerly with Wright Aero has been named promotion mgr of Aviation, Aviation News, and Air Transport

Capt Richard A Harding has been appointed asst to pres of Roscoe Turner Aero Corp.

Walter E Lode joined Kellett as exec asst. to R G Kellett

Richard H Depew, Jr, resigned as chief aircraft sales div of Office of Aircraft Disposal

Stanford J Stelle, formerly with aircraft div of War Assets Administration, has been named mgr of United Air Services Burbank

Harold Montee has been appointed Chicago mgr of Newhouse & Sayre's aviation underwriters

Dr Sanford A Moss has been awarded Franklin Institute's Howard N Potts Gold Medal in recognition of his turbosupercharger work.

Robert E. Ready formerly at Lockheed has been made chief engineer for United Helicopters Inc Berkeley, Cal

Joe E Earll has been named v-p in charge of merchandising for Pacific Airmotive Corp

CAA appointments: Maj R C Shnile returned as gas turbine and jet engine specialist with power plant engineering div in Washington D C; B Allison Gillies has been named to Nonscheduled Flying Advisory Committee and Harry G Tarrington has been made chief div of international activities

TACA appointments: Julius C Holmes has been named airline's pres. and also a director, and **M Archimbaud** has been made asst to v-p in charge of traffic. **Richard W Darrow** has been appointed director of public relations for Glenn L Martin

James A Cox Jr, newspaper publisher has been elected to EAL's board of directors and **C W France** formerly with C W has been appointed airline's v-p in charge of maintenance and engineering.

Roy Van Horn has been named Braniff Airways director of maintenance and engineering

Maj Vincent D Suhr has been made purchasing agent for Air Cargo Transport, and **Merrill M Manning** has been elected to airline's board

Stanley A Hedberg has been appointed press relations mgr of PAA's Atlantic div

Charles Gross joined Aeronautical Products as v-p in charge of sales.

Charles H. Kanavel, of Goodrich, has been named district mgr of company's aviation, automotive and govt. sales div

P K Yost, Jr, has been appointed Lockheed's new domestic sales mgr **Roger Donaldson** succeeds Yost as eastern district mgr **Robert Bliss** has been named Washington mgr and **W Gifford Myers** has been appointed Dayton mgr.

NEW SIKORSKY AND BELL 'COPTERS WIN ATCs

Long awaited era of commercial use of helicopters became a reality when CAA recently licensed both four-place Sikorsky S-51 (top) and two-place Bell Model 47 (above) Eight S-51s have already been sold for use in mining surveys air ambulance and taxi service and package delivery Rated at 103 mph top speed, this craft mounts 450-hp P&W Wasp and has 1,250 lb useful load. Bell is initially building 500 of Model 47, most of which are scheduled to be completed this year With 175 hp Franklin, latter 'copter features 80 mph operating speed and 250 mi range Gross weight is 2100 lb and useful load 607 lb. It's stated that stability tests included "hands off" flight.

Maj Reuben H. Fleet resigned as consultant for Convair

Arthur E Raymond and **Ronald M. Hazen** have been appointed by Pres. Truman to fill vacancies in NACA.

Andrew L Pomery has been named Fairchild's engineering operations mgr

Leonard J Povey has been elected v-p of Gillies Aviation Corp., and will be head of Roosevelt Field, N Y div.

* CANADIAN NOTES *

By James Montagnes

New non-scheduled service air licenses continue to be issued in volume by Canadian Air Transport Board Among new licensees are Dept of Public Health Saskatchewan to operate Regina-Prince Albert ambulance service Laurentian Air Services Ottawa, to operate service to St Jovite Que Frederick Henkell Wheeler for services from Montreal to St Jovite and Ste Agathe, Que Superior Airways and Thunder Bay Airlines to fly from Fort William, Ont Canadian Pacific Airlines to operate out of Roberval, Que and Quebec Airways, subsidiary of CPA to operate out of Mont Joli and Baie Comeau, Que

Dominion decision to permit Canadian Pacific to operate airline subsidiaries for at least an additional year is taken in airline circles to mean government is modifying, and may even drop entirely its earlier policy calling for divestment by railroads of all airline ownership.

First Canadian newspaper to acquire aircraft is Free Press, of London Ont which has filed Cessna Crane for news work

Assignment by government of $... for building airport at Yellowknife gold camp on Great Slave Lake Northwest Territories, is part of program of new aviation development in outlying areas. Field will enable year-round traffic without present restriction to lake landings using floats in summer and skis in winter

Under sponsorship of NAA of Canada, a major air show will be run at de Havilland Airport Toronto, Aug 30 through Sept 7 Meanwhile NAA announces its third national convention is slated at Toronto Jun 14-15

Manufacturing: Fairchild Aircraft, Montreal is readying new single-engine bush freighter, F-11 Husky with initial deliveries expected by late June or July Fitted for floats skis or wheels craft is to sell for about $33 000 mounting used P&W S3H1 or T1B3 engine Aircraft designed to carry eight passengers or bulky freight has specially wide doors and floor height for loading Three-place helicopter SG Mark VI is being built at Montreal by Engineering Products of Canada for Intercity Airlines, Montreal. Tests are scheduled this month.

* OBITUARY *

Ethel V Noska Principal of Manhattan High School of Aviation Trades Entering school system in 1938, he taught both shop and academic subjects becoming head of the aviation school upon its formation in 1933 Under his direction thousands of airplane mechanics were trained for peacetime and war services

Groundwork Laid for NACA-PAC Research; Get Many Design-Improvement Proposals

. . . Air policy bill up . . . Mead report awaited . . . Aircraft output tallied . . . Reveal employment data . . . Order for 240s questioned . . . Test sweepback prop-tips.

"Close coordination of research activities affecting the continued development of personal aircraft has been agreed upon by the National Advisory Committee for Aeronautics and members of the Personal Aircraft Council," according to announcement by William T Piper, chairman of the Council, a division of Aircraft Industries Assn

Observers attach much importance to this decision because, whereas production of military and transport aircraft is normally limited, there is a definite possibility that personal-type planes will become the basis of a major industry—if mass acceptance of them is achieved through improvements in utility and in safety.

NACA has recently received 41 proposals of design projects for promotion of lightplane performance utility, safety, and economy — eight from CAA Administrator T P Wright, 18 from Aircraft Owners & Pilots Assn., and 15 from AIA And scores of other suggestions are being received from other sources

Among the 41 proposals are: Reduction of prop and engine noise; gas-turbine-propeller combination power plant; jet-driven prop blades; summaries of NACA engineering data applying to lightplanes for convenience of designers; wing design permitting 200 mph cruising, 35 mph landing, 150 hp engine weighing not more than 150 lb; low power gas turbine; cross-wind landing gear light, cheap cartridge engine starter; adjustable pitch propellers and lightweight mufflers Most studies suggested by AIA are for refinement of present designs.

John W Crowley, acting NACA director of research, told AVIATION editors that NACA will employ its facilities and manpower, over and above those needed for defense research, on civil aviation, with new emphasis on lightplanes He said that proposals from all sources will receive equal consideration

The Director pointed out that NACA is already engaged in many projects which benefit personal flying as well as other aviation NACA had already begun the compilation of data for the special convenience of lightplane designers

NACA recently initiated a twelve-point National Aeronautical Research Policy which carries endorsement of the military air services civil agencies for government, and the aviation industry Incorporated are the principles of (1) fundamental research by NACA (2) civil and military applications by the industry and (3) evaluation of military equipment by Army and Navy (These cooperative functions for technical progress were specifically advocated more than a year ago—Mar 1945—in an AVIATION editorial.)

Order for 240s Questioned

CAB instructed the Aviation Corp, Consolidated Vultee and American Airlines to show cause why an AA order for 100 Model 240 Convair planes should not be prohibited on the ground that Avco holds controlling interest in the other two firms and that the transaction would be detrimental to the public interest because AA might not have had a free choice in its selection of equipment CAB had previously ordered Avco to reduce its AA holdings to 4%

Air Policy Bill Up

Hearings are scheduled to begin on Sen Mitchell's bill (page 40, Apr AVIATION) to create a National Air Policy Board similar to the Morrow Board established in 1925 In the time of the Morrow Board aviation was a negligible factor in warfare and an uncertainty in commerce Since then it has become the major weapon in war and its long range, high speed, and capacity for heavy lift are now seen revolutionizing human communications

Sponsors of the Mitchell measure feel that this country needs an entirely new aviation policy in defense and commerce and that on this policy will depend the nature and extent of the aircraft manufacturing industry.

Mead Report Awaited

Due now is the report of the Mead War Investigating Committee (formerly the Truman Committee) which will emphasize the need for an aggressive research program to maintain American technological superiority in military aviation The Committee's aviation subcommittee wrote the report after extensive hearings attended by aircraft executives on both East and West Coasts

Aircraft Output Tallied

Figures released by CAA and AIA indicate that 2 047 civil airplanes were produced in 1945 Production jumped from 10 in July, right after V-J Day, to 787 in December Total includes only machines manufactured under the CAA type certificates does not cover experimental models Two-place models of 51-100 hp accounted for 84% of total civil craft built

An average of 2 500 per month would be necessary to reach the industry's goal of 30 000 in 1946 Manufacturers report orders on hand for 50 000 Production reporting functions of the wartime Aircraft Resources Control Office have been taken over by CAA Output of military airplanes in 1945 dropped from 5,419 in January to 192 in December, tallied 46 613 for year

Reveal Employment Data

Employment in all aeronautical plants dropped from 1,056 236 in Jan 1945, to 183,338 in December, in airframe plants from 723,850 to 148,789, in engine plants from 288 233 to 28 422, in propeller plants from 48 153 to 5 115 The statistics compiled by Bureau of Labor Statistics and released by AIA cover prime contracting only.

Word on March military acceptances put total at 107 craft, including 65 target jobs In February the Army took delivery on 116 airplanes and Navy 56, totaling 175 weighing 1 046,600 lb. March acceptances totaled 163, weighing 1 168,200

February breakdown: Army took 7 Boeing B-29s 4 North American P-82s, 3 Bell RP-63Gs, 41 Lockheed P-80As 4 Fairchild C-82As, 1 Curtiss C-46G, 4 Sikorsky R-5As, and 55 Culver PQ-14A targets Navy took 2 Martin PBM-5s, 2 Douglas XBT2D-1s 5 Grumman F7F-3s, 4 Goodyear F2G-1, 21 Chance-Vought F4U-4s, and 24 Grumman F8F-1s.

Test Sweepback Prop-Tips

Sweepback in propeller-tip design is being tested to overcome shockwave due to air compressibility, just as it is used in wing arrangement for the same purpose NACA and other investigators have demonstrated that sweepback airscrew can raise the normal efficiency of 84% at 200 mph and 60% at 530 mph to 83% at 300 mph and 86% at 530 mph It is believed that such propellers can exceed the efficiency of jet thrust in the 500 mph category

DIESEL TESTED IN PERSONAL PLANE

A 4 cyl Thaheld Diesel engine installed in this Stinson 105 personal plane is stated to offer a low fuel-oil consumption of 2.3 gal/hr Engine stated to weigh 235 lb., gives craft a 90-mph cruising speed (Press Assn)

* INDUSTRY MEMOS *

Republic Seabee deliveries are scheduled to start this month, with output set at 40 daily by Aug Plans call for 5 000 of craft to be produced this year. Agencies have been established in Canada, Hawaii, Cuba, Mexico, and various European and South American countries.

Packard is experimenting with J P aircraft engines at government owned facilities in Toledo and at Willow Run Army Air Base.

Globe has orders for 3 000 Swifts with 125-hp engines and 2500 with 85-hp planes

Aeronca acquired 70,000 sq. ft. of additional manufacturing space at Vandalia, Ohio, and plans immediate production there. Total Chief and Champion production at Vandalia and Middletown is expected to reach 40 daily this month.

North American Navion production is expected to hit 10 a day in July, according to company officials CAA is expected to certify four-place personal plane was hoped to be completed this month. Meanwhile a distributorship organization is being formed and demonstration craft are being built

formed and demonstration craft are being built.

Convair signed $1,000,000 contract with WAL calling for a score of model 240 transports. Maker has four versions of craft planned: With P&W R-2800 Double Wasps, with Wright R-3350 Cyclones, with GE TG-180 turbojets, and with P&W Double Wasps plus wingtip-mounted turbojets.

Hallicrafters announces reception from Republic of what it terms largest postwar contract for personal plane radio equipment.

Commonwealth turned out first production Skyranger at company's new plant at Valley Stream, L. I., N. Y.

Boeing received orders totaling $1,000,000 for ten Stratocruisers for Northwest Airlines with first delivery scheduled for early '47. Company also signed contract for eight Stratocruisers with AA, amounting to over $10,000,000.

Standard Oil of Indiana is planning to purchase seven planes for business purposes—Lockheed Lodestar, a Beech 18, and five unspecified personal-type planes.

Hamilton Standard graduated 3,000th student from its service school, now located at home plant in East Hartford, Conn.

Wright Aero purchased Wood-Ridge, N. J., plant from Government and will gradually consolidate all other manufacturing and office facilities in Paterson area to new acquisition.

First IAS national meeting devoted entirely to aircraft propulsion was held at Cleveland, and ten papers were featured. These included "Vapor Lock and Pump Selection in Aircraft Fuel Systems," by Robt. S. Ames, Goodyear Aircraft Corp.; "Propellers for Aircraft Gas Turbines," by George Brady, Propeller Div., Curtiss-Wright Corp.; "Aircraft Ejector Performance," by Frank A. McClintock, Pratt & Whitney, and co-authored by J. Hall Hood, Convair; "Gas Turbine Power Controls," by R. Bodemuller, ATSC; "The Axial Compressor and Its Aeronautical Applications," Ensign Frank J. Gardiner, Navy Bureau of Aero.; and "Practical Considerations of Aircraft Gas Turbine Design," Samuel R. Puffer, General Electric. Talks by NACA members were "Extension of Useful Operating Range of Axial Flow Compressors by Adjustment of Stator-Blade Angles," by John T. Sinnette, Jr.; "Considerations of Inlet Designs for Supersonic Ramjets," by DeMarquis D. Wyatt; "Analysis of Pressure Losses in Jet Propulsion Engine Combustion Chambers," by Irving I. Pinkel; and "Dimensional Analysis of Performance of Jet Propulsion Engines," by Newell D. Sanders. As guests of NACA group toured Aircraft Engine Research Laboratory.

All three Air Material Command procurement districts—Los Angeles, Chicago and N. Y.—have been discontinued as separate AAF installations. They have been replaced by eleven Procurement Field Offices located in Boston, Chicago, Cleveland, Detroit, Los Angeles, N. Y. C., Rochester, St. Louis, Dallas, Atlanta, and Dayton.

★ FOR THE RECORD ★

American Navigation Assn. is new non-profit organization open to anyone interested in any type of navigation. Log of Navigation has been adopted as official organ. National hq. are at Merchants & Manufacturers Bldg., Houston, Tex.

Gillies Aviation Corp., Hicksville, L. I., completed negotiations with Roosevelt Field, L. I., for exclusive aircraft sales rights at field. Company is devoting a hangar exclusively to aircraft display.

U. S. Aviation Underwriters opened new eastern dept. at 80 John St., N. Y. C.

Air Associates have been appointed distributor for Parker Appliance Co.'s fittings, valves, plug and drain cocks and other aircraft specialties.

Liberty Aircraft Products Corp. purchased patent rights to Van Vleck aviation refueling unit.

Empire Airlines, of Lewiston, Ida., absorbed Zimmerly Air Lines and now operates intrastate routes of latter.

Sinclair Refining Co. opened aviation sales div. branch office in Tulsa, Okla.

E. W. Bliss Co., machinery maker, transferred executive offices from Brooklyn, N. Y., to 450 Amsterdam St., Detroit.

New Accounts: Charles H. Gale Associates, N. Y. C., now has public relations accounts for Piper Aircraft Corp. and also Electrol Inc. . . . West-Marquis, Inc., Los Angeles-San Francisco, has been appointed as marketing and public relations counsel for United Helicopters, . . . Bernard Relin Associates, N. Y. C., has been named public relations consultants for Air Force Assn. . . . Wain & Baruch, N. Y. C., is new public relations agency for Commonwealth Aircraft Corp. . . . Aircraft Products Co., West Chester, Pa., to John Falkner Arndt & Co., Pa. . . . Royal Dutch Airlines (KLM) to Charles W. Hoyt Co., N. Y. C.

Atlas Aircraft Products Corp., electrical equipment maker, has bought building at 48 44th Rd., Long Island City, N. Y., from Machinery Builders, Inc.

METAL PROP WITH WOOD CORE
This small nickel-plated wood prop shows promise of being an important development in personal plane industry. Having advantage of offering durability features of metal prop at a fraction of cost of present forged blades, it is created by applying to a preformed blade core an electroplate of nickel of accurately controlled thickness. Plating process itself can be controlled to give extra thickness to blade's leading edge. New design, developed by Navy in cooperation with Bonr Engineering Corp., is undergoing extensive testing. It is stated that several propeller makers have indicated interest.

Route Agreements Provide Global Network; Pact With France Notably Comprehensive

. . . Report PICAO progress . . . TWA makes broad strides . . . Draft safety code at Dublin . . . UAL flies Pacific for ATC . . . IAT bands N-S carriers

U S has now negotiated agreements extending its air routes into nearly every region on the globe Prime exception is Russia However, terms were discussed with the latter before the Chicago conference and now at press time word comes that the U S S R has agreed to confer regarding the drafting of a commercial U S-Russia aviation pact

Most far-reaching of the recent agreements is that with France which opens to U S carriers all air bases built partly or wholly, by U S on Tricolor territory during the war Also provided for are 8 U S routes across the Atlantic to the Far East across the South Atlantic to South Africa across the Pacific to the Orient, plus routes in the Caribbean

France gets five Atlantic routes with entry into New York Washington Chicago Boston, Puerto Rico, and the site of UNO Thus France is first country officially authorized to serve UNO's future home in the U S The agreement imposes no limitation on schedules so long as capacity does not exceed available traffic Any disputes will be referred to PICAO at Montreal

No major nation except the U S has ratified the Five-Freedoms agreement reached at Chicago and indications now are that air reciprocity will be bilateral

Report PICAO Progress

First step toward establishing an up-to-date and effective airworthiness code for civilian planes operating on international routes was taken by PICAO in its Airworthiness Div s first meeting at which 27 experts represented eleven nations It is intended first to review and revise Draft Annex G which sets forth proposed standards drawn up at Chicago Separation of airworthiness rules from operating rules is desired and two different divisions have been set up to handle this work—Operating Standards and Airworthiness

Removal and minimizing of obstacles to air travel at international borders is proposed in a document sent to 42 member states Following recommendations were submitted That precise meanings of such terms as customs airport, transit area cargo, stores etc., be defined; that International Travel Cards replacing passports and visas, be issued by each state to its nationals to encourage tourist and business travel by air that there be established custom-free airports, standardized customs forms and simplified hygiene standards

Proposed is an International Certificate of Inoculation and Vaccination designed to combine (in book form) all different certificates required by International Sanitary Convention of 1933.

TWA Makes Broad Strides

Trans-World Airways (TWA) will assist in the organization and operation of Iranian Airways which will serve neighboring countries following acquisition by the U S firm of 10% of the Iran company's stock TWA also has acquired 40% of Italian Airways 25% of Philippine Airways has a two-year option to purchase not more than 25% of Ethiopian Airways, and has increased its holdings in TACA Airways S A Company's long-planned expansion is well under way and in 1946 a ton-mile capacity three times that of 1945 is scheduled

Draft Safety Code at Dublin

Conference of North Atlantic air operators held at Dublin under auspices of PICAO agreed after 23 days of discussion on a code of rules intended to insure maximum safety Findings of the conference held at Dublin have gone to the PICAO interim council at Montreal and if approved will become standard safety procedures in the North Atlantic and probably later in the other zones in which further conferences are to be held

UAL Flies Pacific for ATC

Army ATC has contracted with UAL and subcontractors to operate 40 Douglas C-54s between California and Tokyo via Hawaii and Guam This service to supplement present military trips calls for one daily flight to Tokyo and one daily to the Philippines plus three daily connections to Hickam Field, Hawaii

Secretary of War Patterson announced that top air priority had been given to all airmail to and from troops in Japan, Philippines, Okinawa, and other Pacific areas Much airmail has gone by boat recently due to reduction in personnel and in plane schedules

IAT Bands N-S Carriers

The Institute of Air Transportation formed by nine charter, contract and other non-scheduled cargo and passenger carriers is making a "coordinated effort toward a nationwide system of efficient and effective carriers"

Member companies operate 75 planes and have on order an additional 30 It is announced that a network of inspection and maintenance points throughout the country will be sponsored Mutual policies on air cargo routing rates, and packaging, for the benefit of growers, manufacturers jobbers and consumers are being studied The organization hopes to bring order out of the present confusion in this field

★ CROSS COUNTRY ★

New Empire Airlines began service from La Guardia Field N Y to 3 upstate N Y communities, using four-place Cessnas Ten Beech 18 transports are on order

American Air Express Corp completed its first round trip coast to coast flight when it flew a cargo of fresh vegetables to N Y Devoted solely to express and cargo hauling airline operates four Douglas DC 3s expects to have six more next month

Airline rental of maintenance buildings of former Denver modification center recently turned over to city is expected to bring in up to $132,030 yearly income UAL is first tenant paying $70,000 yearly WAL will take half a hangar at $58,083 and UAL is currently negotiating for space

Records TWA Lockheed Constellation made Los Angeles-K C-N Y hop in 7 hr 33 min at 285 mph average ground speed And another of airline's Constellations made Chicago-N Y flight in 2 hr 8 min at 348 mph average ground speed . . . PAA Constellation made San Francisco-Honolulu flight in 9 hr 33 min . . . PCA Douglas DC 4 made Milwaukee Pittsburgh hop in 1 hr 41 min

Packaging protection for airborne perishables was demonstrated by Celanese Plastics Corp in exhibit of Lumarith materials at '46 Packaging Exposition at Atlantic City

PAA Airline will use Schenectady Airport as emergency field for eastbound operations . . . Company began series of weekly charter flights to Shanghai via Tokyo under contract with UNRRA, using Lockheed Constellations . . . Subsidiary Panagra received Annual Aviation Safety Award of Inter-American Safety Council for completing '45 without a single accident or fatality to passengers or crew

AA: Company extended trans-Atlantic system to include Oslo Norway . . . Company finished installation of private coast-to-coast telephone line, with lie-lines to all intermediate points

UAL Airline started daily flights from Calif to Hawaii, Guam, and Tokyo using Douglas DC-4s . . . Company inaugurated special Nurseryliner service exclusively for mothers and children, with Douglas DC 3s outfitted with diapers baby foods, and toys, and with two trained nurses aboard . . . Airline is consolidating all ground training at Cheyenne.

TWA Airline started regular service between U S and Cairo, Egypt . . . Company also introduced service for mothers with baby kits put on its planes Kit given mother when she boards craft, contains six diapers bath sal talcum feeding bottle with nipple, canned milk cans of strained spinach prunes carrots and cereal At end of trip, mother keeps kit as souvenir . . . Airline began trips to Cairo with flight time for 6,254-mi hop gaged at less than 25 hr

SIDE BY SIDE IN A DC-3

Strictly utilitarian this surplus Douglas C-47 owned by Davis Airways Skytarpalines Boston Airport, is seen filled with paratroop style passenger accommodations. Side bench type reconversion has obviated higher costs of deluxe seating (Press Assn photo)

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Snap-on builds Vacuum Grip pliers in a modern plant devoted exclusively to the production of the finest, most efficient pliers that can be produced. Vacuum Grip pliers are hammer forged from special high carbon chrome-silico-manganese alloy tool steel, hardened and tempered through and through. Light in weight, perfectly balanced. Smooth, easy riding joints, sharp, deeply milled teeth. Hand filed, perfectly aligned cutters. Spring-tempered, "Vacuum Grip", non-slip handles.

A famed name in Snap-on's complete line of more than 3,000 tools for production and service, Vacuum Grip pliers are available everywhere through Snap-on's nation-wide direct-to-user tool service.

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★ INTERNATIONAL BRIEFS ★

ENGLAND—Schedule for Tudor II calls for 1946 production of 40 to 50 planes to carry 60 passengers at 280 mph.

Saunders Roe announces program for a 110 ton flying boat powered by six gas-jets to carry 100 passengers non-stop from London to New York at better than 350 mph. According to designers, plane could be placed in service within 3 yrs.

British Provincial General reports plans for starting inland airmail service before end of year. Based on night-flying schedule, British public would be guaranteed over-night delivery to all points in isles.

British European Airways, nationalized company serving Europe, is now operating Douglas Dakotas for passengers and Vickers Warwick planes for freight. Services include connections to Paris, Brussels and Amsterdam, with routes to Denmark, Norway and Sweden still in discussion stage.

Prelim figures on new Bristol Freighter indicate plane can carry 4½ tons 360 mi. at 168 mph. at cost of 13.76 per ton-mile. Equipped with 32 seats, cost per seat-mile is put at 1.1¢, excluding revenue from mail and express carriage.

Here's reported performance of new Miles Messenger: Cruising speed 110 mph; takeoff within 140 ft. into a gentle wind; stalling speed 30 mph, and landing approach gliding speed 45 mph.

FRANCE—Signing of a British-French air pact with modified "fifth freedom" terms is expected to give Paris half-hourly service frequency to London.

Air France is expected to start New York service next month on weekly basis, flying Douglas DC-4s.

EIRE—A neglected entrant in Atlantic lineup is Eire, which announced at PICAO Dublin conference that it planned to start service in 47.

SWEDEN—This nation's airlines operated more than 14,000 route miles in 45; flew over 20 countries carrying 51,000 passengers and flying more than 2,000,000 mi. In addition, 27 experimental flights to New York were made with converted Boeing B-17s carrying more than 65,000 lb of assorted mail and freight.

Swedish Airplane Co. is now testing a new 3 place 127-mph tricycle-geared personal plane. Also, 20-passenger airliner is to be ready for test in late summer.

ITALY—Formation of new Italian civil airline company, with TWA holding 40% interest, has pleased interests in English circles which consider this move as an encroachment.

GREECE—Recent "fifth freedom" air pact completed with U.S. opens way for inter-airlines through Athens. While no service to America by Greek interests appears forthcoming, they have applied to PICAO for financial and technical aid to re-establish aviation facilities.

HUNGARY—New 30-yr aviation agreement with U.S.S.R. provides for Russian installation of facilities on Hungarian airfields.

ETHIOPIA—Agreement made with TWA provides for line's complete control of all aviation activities in this country. Planned services include Addis Ababa-Cairo route to be operated with converted Douglas C-47s, also interior service with Norseman craft.

SAUDI ARABIA—Dhahran airport will soon be used by air lines of all nations. TWA's contract with Ibn Saud for maintenance of the personal aircraft is generally felt to include operation of airport for nation.

India—TATA Air Lines is now operating Douglas DC-3s over 2,500 mi. per day, connecting Karachi, Colombo, Bombay and Delhi, also Calcutta service is expected to start soon. Company recently completed ticket-interchange agreement with PAA.

PHILIPPINES—Improvement in islands' air services is seen in recent allocation of DC-4s to country's two airlines. Nielsen airport, near Manila, is to be international airport under management of new company.

AUSTRALIA — Bi-weekly service to Vancouver planned by Australia National Airways. Report is now received that Australian Government is projecting broad unfurnished air routes— which would include service to Canada—hence it's expected that ANA will be forced to discontinue any service to Canada when these operations start. It is said that government will buy Merlin-powered Douglas DC-4s.

Freight service instituted by ANA to and from Tasmania have been successful enough to warrant conversion of several DC-3s to cargo planes. Thus far loads have included strawberries, lobsters and fish fillets. Most transport is expected later this year.

Recent test hop in Australia of Avro Lincoln was first flight of a four engine plane built there. Orders have already been placed for a small number of these craft.

Australian flying clubs are to be subsidized by government with payment of $125 for each 36 hr flown per craft and with bonus of $250 for each pilot trained from scratch to ou A license. Also, free hangar space will be available.

Capitalization of ANA has been increased to £1,000,000 (approx. $3,2??,000) to finance purchase of DC-4s now on order or being delivered. Options for DC-6s may be taken up this summer.

BRAZIL—Delivery of first Lockheed Constellation to Panair do Brasil is expected to enable company to start projected service to London this summer.

New domestic airline is the Cia. Meridional de Transportes, which is operating three aircraft between Rio and Volta Redonda, site of new Brazilian steel plant.

Two new airlines are in process of formation — Viacao Aerea Baiano and Viacao Aerea Centro Oeste. No route plans have been announced thus far.

ARGENTINA—Strong U.S. diplomatic action against this country resulted in attempts to form anti-foreign-competition bloc with Brazil and Chile. Latter two are not enthusiastic, but cancellation of the Panagra stops by Argentina may be forthcoming.

Order has been placed for ten Avro 19s for FAMA state-controlled airline. Further orders for Tudor IIs are also said to be under discussion.

VENEZUELA — Million - dollar airport at Caracas with 1½-mi runways was recently dedicated.

MEXICO—Aerovias Braniff won point against PAA when Mexican Supreme Court decided Braniff was entitled to operate Mexico City-Merida route.

WORLDATA . . . . By "VISTA"

All is not serene in England these days. The nationalization program which initially bogged down in arguments on cost to taxpayers, has now taken a backseat during the storm of protest concerning purchase of American aircraft, specifically five Lockheed Constellations. With criticism widespread, general English consensus appears to be that British industry has been betrayed and its future nullified—robbed of the chance to show that it could produce better and more modern aircraft for trans-Atlantic service.

The situation has been aggravated by announced purchase of 72 Douglas C-47s for BOAC from U S Surplus, utilization of Junker 52s for some British domestic services, and cancellation of British Boeing 314 service to Baltimore. Considering that British believe the York and Lancastrian are superior planes in range and load-carrying capacity, it is surprising U.K. has not started trans-Atlantic service with these craft. Meantime, there is grave concern in London aviation circles over the head-start AOA, PAA, and TWA are getting.

In Scotland, talk has arisen of a separatist movement on air services, with Scottish interests desiring to form a public company to operate airlines independent of British nationalized system. Scottish Airways has long planned extensive international air services. This organization's recent survey flight to America with a converted Convair Liberator, lends weight to reports of company's intent to start Prestwick-New York services.

Little aviation news is ever available from Russia, but occasionally the veil is lifted to remind us that aviation progress continues in the U.S.S.R. A recent broadcast described three new types developed by Designer Yakovlev—the "8" twin-engine feederliner especially designed for small poor fields, the "14", designed to be a "motorcar of the air" carrying four persons and powered with a 150-hp engine, and a courier plane of high speed and great range equipped with a small office for the official traveler. Broadcast stated that mass production of Yakovlev "14" was expected to bring price down to cost of Russian automobile."

SUMMER SOARING IN SOVIET

Student pilot of Moscow Parachute and Gliding Club is depicted landing a Russian glider in an open field. Tandem placer has boat shaped nacelle with tail boom supporting tail surfaces. Tapered parasol wings are supported by airfoil-shaped twin struts. (Sovfoto)

Glenn L. Martin Co. expects sales of \$40 000 000 this year \$70 000,000 in '47 and \$100 000 000 in '48 according to Pres. Martin This year's business which should cover \$3 annual dividend, will include \$26 000,000 in military aircraft conversions. Production of 250 Model 202 transports is needed to write off tooling and development expense, after which only 10 planes a month need be produced to break even. Orders for 700 planes of this type are expected in next two years.

Douglas reports 1945 net income of \$8,355,754 or \$14 93 a share against '44 net income of \$7,685,227 or \$12 81 a share Sales were \$744,682,804 against \$1,061,407,000 in '44 Pres. Douglas revealed that a \$40 000 000 bank credit has been arranged to provide against possible larger working-capital needs

Ryan Aeronautical Co. has signed contracts totaling more than \$2,500,000 in new exhaust manifold business in its stainless steel division

Grumman reports 1945 sales of \$238 846,862 against 1944 sales of \$323,749,331 Net income last year was \$5 713,529 or \$11.24 a share against '44 net income of \$9,350 000 or \$18 80 a share Pres L H Grumman pointed out that at V-J Day more than 80% of \$380 000 000 contracts on books were cancelled None of company's experimental contracts have been cancelled

American Airlines plans to raise \$89 000 000 this year through sale of debentures and convertible preferred stock. First step was taken Apr 17 when stockholders authorized a new issue of 600 000 preferred stock Proceeds will be used to buy equipment, expand services, and retire a \$25 000 000 bank debt

Republic reports 1945 net income of \$1,889,778 or \$1.82 a share against '44 net income of \$5 141,440 or \$5.23 a share Sales were \$222 148,328 in 1945 against \$369,593 425 in 1944

Eastern Air Lines reports 1945 net income of \$2 128,294 or \$3 56 a share against 1944 net income of \$1,489 337 or \$2 54 a share Total revenues were \$27,189,000 against \$18,809 000 in 1944. New equipment now on order will give Eastern a seat capacity some 600% over that of 1941

Thompson Products has sold 40 000 shares of 4% cumulative preferred stock and 75 000 shares of common stock through an underwriting group of bankers Proceeds will be used to purchase Euclid Ohio plant of Thompson Aircraft Products Co (which has been operated under lease from government) and for capital improvements and additions.

National Aviation Corp. investment company, probably will receive \$300 000 in dividends and interest this year against \$352 000 received last year. Pres. Robinson predicted that some aircraft concerns will disappear in next few years through mergers or movement into other industries.

Lear Inc. reports 1945 net income of \$657 108 or 38c a share Sales totaled \$31 168 176 Company retired \$4 000 000 of its Reconstruction Finance Corp loan last year and expects to pay off remaining \$2 500,000 this spring

Kellett reports \$3,355,000 in unfilled orders as of Mar 15 Approximately \$500 000 is on experimental helicopter projects for Army and Navy Net income in 1945 was \$217 767 or 51c a share against '44 net income of \$143 908 or 33c a share Sales were \$12,373 000 against \$11 839 000 in 1944

National Skyway Freight Corp., of Los Angeles, is publicly selling 500 000 common shares at \$5 a share Net proceeds of \$2 148 000 will be added to working capital and used to purchase new airplanes

Square D Co reports 1945 net income of \$1 621 462 or \$3 40 a common share against 1944 net income of \$2 011 464 or \$4 58 a share Sales were \$40,317 000 compared with \$40 541 000 in '44

TACA Airways will offer 500 000 common shares to public through a group of underwriters.

United Air Lines reports 1945 net income of \$4 203 815 or \$2 34 a share against 1944 net income of \$6,114,991 or \$3 78 a share Operating revenues were \$39,347,000 against \$35 629 000 in 1944 United is spending \$60 000 000 on postwar expansion.

Airline reports; Airlines announces 1945 net income of \$4,339,458 or \$3 36 a share, against '44 net income of \$4,399 163 or \$3 41 a share Braniff Airways reports 1945 net income of \$849 839 or 85c a share, against '44 net income of \$773 985 or 77c. a share TWA reports 1945 net income of \$1 813 578 or \$1 84 a share against '44 net income of \$2 752,980 or \$2.82 a share Pennsylvania-Central Airlines recorded 1945 net income of \$441 467 or 92c a share against '44 net income of \$404 935 or 81c a share Western Airlines reports 1945 net income of \$208 102 or 51c a share, against '44 net income of \$125,828 or 33c a share.

United Aircraft Corp. reports unfilled orders of \$110 000 000 at end of 1945 lowest since '38 when they were \$17 000 000 Net income last year was \$12 855,260 or \$4.35 a common share against '44 net income of \$15 562,339 or \$5 37 a share Sales were \$484 310 000 against \$743 527 000 in '44 From V-J Day to end of 1945 postwar adjustment expenses of \$732 000 were charged against a \$28,078 000 reserve for such expenses.

Solar Aircraft Co has purchased Hubbard Casket Mfg. Co of San Diego Nationwide distribution of a stainless steel casket (already being manufactured at Solar's San Diego plant) is planned

ADDING IT UP . . . . . By RAY HOADLEY

Stock Splits. The airlines have joined the parade of companies who have split their common stocks Eastern has declared a four-for-one split in its common stock, while American Airlines proposes to give common holders five shares for each one now held Split-ups are not new in the airline field, for American (in 1944), Braniff and Delta have all split their stock since 1940. However we can't recall any split in the stock of the aircraft manufacturers in recent years

Reason for Split-Ups. Any one, or all, of five reasons may be given for the current popularity of this stock-splitting process 1 It effects wider distribution of the stock, 2 creates interest in the stock 3 bolsters relations with the public, 4. increases sales and markets via the stockholder route, and 5 reduces per-share earnings and thus cushions labor and political charges of excessive profits

Dividend Upsets. The problems involved in doing business during the reconversion period have caught up with American stockholders. Many companies have recently omitted their regular dividends, among them such companies as Curtiss-Wright and Continental Motors. However Boeing Airplane Co temporarily reversed the trend by declaring a \$1 dividend after a lapse in payments of only six months Boeing recently has received substantial commercial transport orders Although current volume for Curtiss-Wright is at rather low-ebb the company is in the best financial condition in its history

Flying Insurance. Of 104 life insurance concerns recently surveyed 75% said they will write policies for owner-operators of private planes at an extra premium of about \$5 per \$1,000 of insurance In 1940 only 42% of these companies would insure such persons, and the extra premium usually was \$12

Martin on Incentive Pay. Glen L Martin favors profit-sharing plans as an employee incentive He recently told a group of security analysts that his company might consider sharing profits 50-50 with labor above the point where the \$3 annual common dividend was covered

Selling AA Holdings. Aviation Corp is preparing to sell 210 000 shares of American Airlines to conform to a 1945 CAB order to reduce its American holdings to 4% Aviation Corp will still have nearly 50,000 shares of American after this deal is concluded

Airline Financing Airline financing again is a major topic of conversation in banking circles TWA American Overseas Airlines United and Northwest are among the lines said to be candidates for loans or financing to handle their equipment expansion

FRED HERSCHELMAN, JR., has been assigned to DAL as chief inspector. Previously air carrier inspector of maintenance for CAA he learned to fly in '27 and has been employed by several airlines including PAA where he was with Pacific Alaskan div.

WALTER T. BONNEY has returned to Bell Aircraft to take post of director of public relations at company's Niagara Frontier Div. Leaving in '44 to enter military service, he was discharged in Mar. '46. He initially came with Bell in '41 as asst. dir. of p. r.

SIGMUND A. CZARNECKI has been made production engineer for Hamilton Standard Propellers Div., UAC. He will be in charge of all activities of tool and equipment engineering dept. He has been associated with company for part 19 yrs., having joined firm in '26.

PAUL L. THOMAS (left) has been named mgr. of NWA's new plant and equipment engineering div. A graduate in civil and business engineering, he joined NWA in '43 and served as Western field engineer in company's Seattle hq. and later he was chief plant engineer for entire NWA system. **COL. ADDISON H. DOUGLASS** (right) has joined NWA as chief plant engineer and will be in charge of maintaining all existing structures and ground equipment. He was recently discharged from Army after serving since May '42. He commanded 395th Engineering General Service Regiment.

H. G. LESLIE was elected chairman of engineering and maintenance of ATA for 1946. In this capacity he will be in charge of Association's conference program and will make assignments of subjects to be discussed. He was formerly superintendent of maintenance for EAL.

C. W. FRANCE has been elected vice-pres. in charge of maintenance and engineering for EAL. He was formerly vice-pres. of C-W. He flew with AAF and RAF in World War I, and pioneered early airline operations. His hq. will be at Eastern's major operations base in Miami.

ROY H. VAN HORN has been appointed director of maintenance and engineering at Braniff Airways. He was formerly a consultant in engineering and research with the War Assets Corp. in Washington. Earlier he was superintendent of aircraft shops at Kelly Field, Tex.

DAVID E. LUKENS has been appointed engineering representative for Autogiro Co. of America. Previously sales engineer of Summerill Tubing Co., he is experienced in handling problems relating to seamless steel tube applications in both conventional and rotary wing craft.

WILLARD S. PAUL has been appointed production mgr. of Beech Aircraft. He studied aeronautical engineering at Parks Air College, after which he worked for a period on the West Coast as an engineering draftsman. He has been with Beech company since early '41.

LEROY R. GRUMMAN (left), pres. of Grumman Aircraft, has been awarded Medal for Merit by President Truman, being cited for exceptionally meritorious conduct in performance of outstanding service to his country and war effort in design and production of several of most efficient types of aircraft supplied to Navy. **LEON A. SWIRBUL** (right), executive vice-pres. of Grumman, has also been honored by President with award of Medal for Merit for exceptionally meritorious conduct in performance of outstanding service to his country and war effort. Merit award has been described as highest that can be made to a civilian; its military equivalent is Distinguished Service Medal.

CHARLES J. RAUSCH has been appointed director of cargo service for UAL. He joined air line in '36 as a draftsman and aeronautical engineer and has been asst. to regional v-p for part 3 yrs. He will direct operational handling of all air cargo activities including mail, express, freight and baggage.

JEAN H. DUBUQUE, named advertising and public relations director of Lear, Inc., will have complete charge of company's advertising. He was formerly asst. to sales mgr. at Beech. During war he was Lt. Col. in AAF, and holds a pilot's certificate. He's also a member of IAS, AWA, and AOPA.

CAPT. MYRON TRIBUS has received SAE Wright Brothers Medal of 1945 for his paper, "Report on Development and Application of Heated Wings," prepared while he was assigned to Equipment Laboratory, Engineering Div., ATSC, Wright Field. He is at present at College of Engineering, University of Cal.

KEEP POSTED ON

Products and Practices

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INFORMATION TIPS

ENGINEERING DATA

Controllers and Recorders 1
Engineering and technical information on pH theory and measurement, and description of line of continuous pH controllers and recorders, are contained in Bulletin No. pH1362 from The Bristol Co., Waterbury, Conn.—AVIATION, May, '46.

Casting Process 2
Method by which intricate parts of alloys, iron-base metals and various stainless steels are cast so that little machining is necessary is described in 16-page booklet "Haynes Precision Castings" from Haynes Stellite Co., Kokomo, Ind.—AVIATION, May, '46.

Packings Manual 3
Basic principles which influence mechanical packings life, and resultant machine performance, together with information on selection, application, and design of adjacent parts in hydraulic or pneumatic equipment are covered in new book from Graton & Knight, of Worcester, Mass. (A charge of $4 is made for this volume.)—AVIATION, May, '46.

Continuous Cast Bronze 4
Bulletin from Ampco Metal, Milwaukee, describes process of producing continuous cast bronze, also contains tables of alloys and sizes available, physical properties, specifications, and table of rod weights with conversion factors for other alloys.—AVIATION, May, '46.

Industrial Linings Service 5
From Industrial Linings Engineers, Edgeworth, Pa., comes 4-page bulletin outlining services to industry on linings for all corrosion problems. Covered are research information and suggestions on types of linings and application.—AVIATION, May, '46.

Velocity Flow Chart 6
Available from Carpenter Steel Co., Welded Alloy Tube Div., Kenilworth, N. J., is special slide chart for calculation of velocity flow and capacities of heat exchangers. Chart also contains information on physical properties of stainless tubing.—AVIATION, May, '46.

PRODUCTION

Liquid Insulator 7
"Insulize", liquid insulator for electrical systems of aviation engines, and for other uses, is again available from Lumenize Products Co., Chicago.—AVIATION, May, '46.

Welding Tips 8
Resistance welding tips in two general grades has been added to line offered by Stackpole Carbon Co., St. Marys, Pa., and are described in Catalog 1B.—AVIATION, May, '46.

Welding Alloys 9
Vol. 3 No. 7 of "The Eutectic Welder" issued by Eutectic Welding Alloys, New York City, contains article on two new "Eutechrom" welding alloys for use on parts with hard overlays.—AVIATION, May, '46.

Gapless Piston Ring 10
Circular from Auto-Diesel Piston Ring Co., Cleveland, describes new type piston ring without gap. Ring can be used as oil ring while retaining its expanding features, and can be made a contracting ring for sealing shafts and bearings, for replacing packings, and in other applications.—AVIATION, May, '46.

Brazing Alloys 11
Issue No. 33 of "Low Temperature Brazing News," issued by Handy & Harman, New York City, contains information on use of "Sil-Fos" and "Easy-Flo" brazing alloys.—AVIATION, May, '46.

Faster Fastening 12
New procedure reported to reduce materially time required for installation of "Dzus" fasteners is described in booklet from Dzus Fastener Co., Babylon, N. Y.—AVIATION, May, '46.

Welding Inspection Handbook 13
Available from American Welding Society, New York City (at $1.50 per copy) is new 156-page handbook covering inspection of manual metal-arc welding.—AVIATION, May, '46.

Solenoid Valve 14
Stated to give control devices long trouble-free service, new Va-Zoo solenoid valve for use with CO_2, air, water, hydraulic fluids and other media is described in bulletin from Allied Control Valve Co., So. Norwalk, Conn.—AVIATION, May, '46.

Heat Treating Process 15
Bulletin No. 100—"Lindberg Controlled Atmospheres for Heat Treating,"—from Lindberg Engineering Co., Chicago, describes four types of neutral heat treating atmospheres, gives cost per 1000 cu. ft. of each, and lists applications.—AVIATION, May, '46.

Drill and Reamer Charts 16
Containing drilling and reaming instructions for doweling in cast iron and steel, new dowel pin drill and reamer chart is offered by Danly Machine Specialties, Chicago.—AVIATION, May, '46.

New Valves 17
Steel "Weldvalve" in gate, globe, and angle designs (600 lb. through 2500 lb. standards) is described in catalog from Manning, Maxwell & Moore, Bridgeport, Conn.—AVIATION, May, '46.

Hydraulic Control Valves 18
Literature is available on new air and hydraulic control valves developed by Hanna Engineering Works, Chicago. One valve is for use in tubing and light piping applications and another, made in two styles, is foot-operated, packless control for use in air and oil hydraulic cylinder operations.—AVIATION, May, '46.

Angular Contact Bearing 19
Self-contained and used without separator or cap, new angular contact ball bear-

AVIATION READER'S SERVICE MAY 1946

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49	50	51	52	53	54	55	56	57	58	59	60						
NEW PRODUCTS:					61	62	63	64	65	66	67	68	69	70	71	72	73
74	75	76	77	78	79	80	81	82	83	84	85	86	87				

NAME .... TITLE ....

FIRM OR AFFILIATION ....

ADDRESS ....

ing made by **Miniature Precision Bearings**, Keene, N. H., may be applied to electric motors, scale mechanisms, and accelerometers, and are reported to function safely and effectively under heavy loads and high speeds. Descriptive bulletin is available.—**AVIATION, May, '46.**

Metal Fabrication Service **20**

Services of **Hungerford Corp.**, Big Flats, N. Y., in field of metal fabrication are described, and equipment is illustrated, in booklet.—**AVIATION, May, '46.**

Combination Rivet **21**

New booklet from **B. F. Goodrich Co.**, Akron, "Why A Rivet Went Nuts," tells story of "Rivnut", now available to industry in aluminum, brass, steel, and stainless steel, and is offered with several head styles.—**AVIATION, May, '46.**

Flexible Coupling **22**

Circular from **Gear Grinding Machine Co.**, Detroit, describes "Bullflex" flexible couplings using ground steel balls, only flexible element being synthetic product used as overall seal.—**AVIATION, May, '46.**

MACHINERY & ACCESSORIES

Coolant Separators **23**

Topic of 12-page booklet from **Barnes Drill Co.**, Rockford, Ill., is company's line of magnetic-automatic coolant separators.—**AVIATION, May, '46.**

Interference Viewer **24**

Information is available on newly designed interference viewer made by **Optron Laboratory**, Dayton, Ohio, described as simplifying and making more accurate measurements of gage blocks, anvils, sealing surfaces and other precision articles.—**AVIATION, May, '46.**

Duplicating Attachment **25**

Combined air and hydraulic duplicating attachment for use on machine tools to produce work pieces with contours exactly matching thin metal template or master part is described in 8-page folder from **Bailey Meter Co.**, Cleveland.—**AVIATION, May, '46.**

Fly Cutter **26**

Designed for application on shell end mill arbors, two new extra heavy universal fly cutters, manufactured by **New-Field Machined Parts Co.**, Chicago, are described in circular.—**AVIATION, May, '46.**

Power Brushes **27**

In 24-page booklet issued by **Osborn Mfg. Co.**, Cleveland, 15 tables give detailed information on variety of factors entering into efficient power brushing operations and much other pertinent information for brush users is included.—**AVIATION, May, '46.**

Machine Tool Control **28**

Developed for conversion of standard machine tools to automatic or semi-automatic operation new 24v control made by **Electro-Air Devices Co.**, Chicago, is described in pamphlet.—**AVIATION, May, '46.**

Finishing Wheel **29**

Describing new line of finishing wheels with synthetic rubber bond and containing table giving safe max. speeds of each type of wheel bond, bulletin has been issued by **Manhattan Rubber Div., Raybestos Manhattan**, Passaic, N. J.—**AVIATION, May, '46.**

Carbide Drill Bit **30**

New carbide tipped drill bit for drilling holes in concrete, brick, cement, tile and marble is described in bulletin from **New England Carbide Tool Co.**, Cambridge, Mass.—**AVIATION, May, '46.**

Snap-Lock Jig **31**

Bulletin from **Hedstrom Industries**, Chicago, describes "Fetherlite" snap-lock jig made of aluminum alloy. Unit is reported to speed jig operation.—**AVIATION, May, '46.**

Portable Air Hoist **32**

Keller Tool Co., Grand Haven, Mich., offers bulletin describing new ½ ton to ½-ton portable hoist weighing 30 lb., having variable speed and featuring load lowering without air, also built-in safety.—**AVIATION, May, '46.**

Infra-Red Equipment **33**

Brochure of 12 pages from **Fostoria Pressed Steel Corp.**, Fostoria, Ohio, contains illustrations of many applications of infra-red heat to drying operations.—**AVIATION, May, '46.**

Torque Tools **34**

Complete line of torque tools made by **Jo Mfg. Co.**, South Gate, Cal., is shown in new catalog.—**AVIATION, May, '46.**

Portable Magnet Charger **35**

Weighing 75 lb. and measuring 7 x 12 x 17 in., Model 10" portable charger capable of charging practically all permanent magnets, is described in literature from **Radio Frequency Laboratories**, Boonton, N. J.—**AVIATION, May, '46.**

Crank Shapers **36**

From **Smith & Mills Co.**, Cincinnati, comes 24-page illustrated Catalog 45 describing company's line of crank shapers.—**AVIATION, May, '46.**

Thread Ring Gage **37**

Folder 140, from **N. A. Woodworth Co.**, Detroit, describes new type adjustable ring gage stated to insure and maintain roundness throughout max. range of adjustment, through distribution of wear over 360 deg.—**AVIATION, May, '46.**

Portable Belt Conveyor **38**

Called "Power Helper", new portable belt conveyor is described in folder as adjustable from 18 in. high to 45 deg. pitch. It can be extended from length of 6 ft. to 10 ft. in multiples of 1 ft., and may be used alone to load or unload vehicles or employed as part of gravity roller or wheel conveyor. Maker is **Metzgar Co.**, Grand Rapids, Mich.—**AVIATION, May, '46.**

Power Metal Saw **39**

Described in literature from **Wyzenbeek**

& Staff Chicago is new saw and file unit which may be attached to any ¼-in electric drill, air drill or flexible shaft, or to chucks in drill chuck or collet —AVIATION, May, '46

Broaching Machines 40
Zeger Tool Co., Cleveland, has issued new circular describing broaching machines.—AVIATION, May '46

Cone-Drive Gear Sets 41
Line of standardized cone-drive gear sets is described in catalog No. 100 from Michigan Tool Co., Detroit.—AVIATION, May, '46

Hydraulic Equipment 42
Expanded facilities of Hydraulic Machinery, Dearborn, Mich., are outlined in 8-page brochure, together with description of engineering laboratory and production departments.—AVIATION, May, '46

Vibration Isolator 43
Bulletin LK 550 from Korfund Co., Long Island City, N. Y., describes Type LK Vibro-Isolator designed in 26 sizes for rated loads of 75-12,000 lb.—AVIATION, May '46

Welding Process 44
Powder Weld Co., Brooklyn, has issued bulletin describing new system of welding. Process is reported as new method of welding, brazing or surfacing with compositions of powdered materials, including plastics.—AVIATION, May, '46

Soft Hammers 45
Many types and sizes of soft hammers made by Gregory Tool & Mfg. Co., Detroit, are described in 6-page color catalog just issued.—AVIATION, May, '46

Kick Press Converter 46
Bulletin from National Pneumatic Co., New York City, describes new unit, Kit DC-350, which converts kick press to power operation.—AVIATION, May, '46

Gear Checker 47
Red Ring gear checker, made by National Broach & Machine Co., Detroit, is described in 10-page Bulletin C45-21. Checker consists of heavy ribbed surface plate table, with two accurately aligned slots at right angles, head and tail stock and one or more measuring heads.—AVIATION, May, '46.

Height Gage 48
Folder of 8 pages from George Scherr Co., New York City, describes new 48-in. Chesterman height gage for use in measuring larger-sized parts and dies.—AVIATION, May, '46

Testing Machines 49
Available from Steel City Testing Laboratory, Detroit, are six new catalog pages on company's Brinell testing machines and instruments.—AVIATION, May, '46

ELECTRICAL

Precision Resistors 50
Bulletin No. 126 issued by Ohmite Mfg. Co., Chicago, announces complete new line of precision resistors, Series 82, 83, 84 and Type 81.—AVIATION, May, '46

Indicator Lights 51
Catalog No. 46 from Gothard Mfg. Co., Springfield, Ill., describes and gives specifications and engineering data for line of indicator light assemblies for panel board and for instrument signaling.—AVIATION, May, '46

Resistors and Controls 52
Complete line of resistors and controls is described in Catalog No. 46, from Clarostat Mfg. Co., Brooklyn.—AVIATION, May, '46

Buying Guide 53
From Allied Radio Corp., Chicago, comes new buying guide covering radio and electronic equipment. Needs of government agencies and industrial concerns, as well as individuals, are covered, and book is sectionalized for easy reference.—AVIATION, May, '46

Oscillographs and Tubes 54
Specifications and descriptions of oscillographs and of various cathode-ray tubes used with them, are given in two special catalogs from Allen B. Du Mont Laboratories, Passaic, N. J.—AVIATION, May, '46

Relays 55
Now available to industry "Aerotrol" relays manufactured by Cook Electric Co., Chicago, are described in new catalog.—AVIATION, May, '46

STEELS

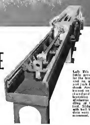
Stainless Steel Data 56
New "Blue Sheets" giving reference data on stainless steel castings (8 pages), stainless Types 347 and 321 (4 pages), Type 416 (4 pages), and 409 shock resisting steel (4 pages), are available from Allegheny Ludlum Steel Corp., Brackenridge, Pa.—AVIATION, May, '46

AIRCRAFT AND ACCESSORIES

Portable Refrigerator 57
Booklet from Celpleaf Corp., Los Angeles, describes new small refrigerator for use in private planes. Dry ice is employed and unit has deep freeze feature.—AVIATION, May, '46

Fuel Tank Caps 58
Bulletin TC from Reylyn, Inc., Los Angeles, describes positive-locking aircraft fuel-tank caps which provide 4-in. dia. hose clearance with overall dia. of 5½ in.—AVIATION, May, '46

Personal Plane Radio 59
Bendix Radio Div., Bendix Aviation Corp., Baltimore, Md., has issued "Radio Sketchbook of Personal Aviation," large brochure in color containing information



about new personal planes and industry leaders behind them.—AVIATION, May, '46.

MERCNANDISING

Catalog Preparation 60

Your Catalog and Publicity Problems is 4-page brochure from **Magazines, Inc.**, Chicago which covers services of publisher in assisting advertiser.—AVIATION, May, '46.

NEW·PRODUCTS

Machinery & Accessories

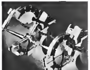
Impact Hammer 61

Mead Specialties Co., Chicago, announces new air hammer unit weighing 3 lb., made to perform wide variety of operations. One application is multiple piercing operations on large sheets. Narrow width of machine permits punching holes on 1⅝ in. centers. There is no specific limit to size of sheet or number of holes punched in one operation. Suitable tables up to 4 ft. by 8 ft. can be made with steel plate 1 to 1½ in. thick. Such tables can be provided with gate so punches mounted on ends can be

swung out to permit insertion of work. Thus all four sides of sheet may be punched at one time. For punching operation machine is normally used in conjunction with standard punching units. Capacity on 200 psi is ⅜ in. hole in ¼ in. cold rolled steel. Hem delivers blow equivalent to approximately 4,000 lb. of force. With various attachments hammer can be used for upsetting rivets, blanking out soft materials with knife dies, light coining and forming operations, and stamping letters on materials. It is available in base sizes 1⅛, 1¼, and 1½ in. wide.—AVIATION, May, '46.

Multi-Turn Split Coil 62

For use in induction hardening of parts of small dia., multi-turn split coil made by **Induction Heating Corp.**, New York City, consists of two or more turns made up of machined copper plates, which are split and hinged to allow coil to be opened, work inserted and coil closed and clamped automatically making contact between segmented sections. Segments of coil are held in place by insulating retainer ring, which forms a closed passage between coil turns. This chamber can be utilized to carry



quenching medium to heated metal without removing work from coil. Both coil segments and supporting leads are independently water cooled permitting continuous operation. Applications are to crankshafts where each journal is hardened individually, camshafts where shaft is progressed and each cam is placed in coil, shafts having large sections or flanges on their ends which prohibit use of ordinary types of induction heating coils and brazing and annealing of sections requiring split type coils.—AVIATION, May, '46

Spinner Riveter 63

Featuring adjustable spindle regulator for precise control of riveting force under max speed, new spindle riveter "Altdex", made by **Plymouth Engineering Co.**, Plymouth, Ind. is suitable for all types of cold headed assemblies, particularly on plastics, fiber, canvas and insulating ma-

terials. Unit utilizes narrow faced tool which contacts fraction of rivet at each blow. Tool is rotated while pneumatic hammer strikes series of rapid blows. Pressure is confined to rivet itself. Wide range of sizes of pistons (diameters run from ½ to 1½ in.) make possible use in riveting small and large fragile parts. Hammers are interchangeable.—AVIATION, May, '46

Shop Equipment & Materials

New Hydraulic Pump 64

Described as revolutionizing hydraulic design, light enough for a man to handle, having continuous duty development of 5,000 psi and 40 hp and delivering 0 to

★ SECTIONAL VIEW OF THE 52 PASSENGER DC-6 AIRLINER

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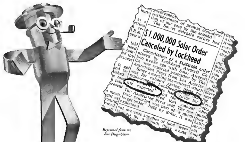

Reprinted from the San Diego Union

Yes! we lost a million dollar order ... and *we feel good about it!* We feel good because we couldn't possibly have received a better commendation of Solar's engineering skill and craftsmanship.

This Lockheed order was for stainless steel exhaust system parts for *replacements* ... but the original Solar-built parts were *so good* that Lockheed found them to have "twice the life expected." Naturally Lockheed cancelled ... and naturally you'll want to know more about Solar's unique ability to produce intricate stainless steel parts ... longer lasting parts engineered to amazingly close tolerances in spite of design complexities.

SOLAR

STAINLESS STEEL

Solar exhaust system parts last longer

Lockheed found that Solar-built exhaust systems had *"twice the life expected"* ... double the hours ... double the air mileage ... saving in this case $1,000,000! Better check with Solar on the savings *you* can make by using Solar exhaust system parts. Write or call your nearest Solar office.

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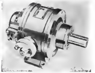


17 gpm. at 1,200 rpm., "Superdraulic" pump is made by **Hydraulic Machinery & Superdraulic Corp.**, Dearborn Mich. Maker states new pump generates desired tonnage for hydraulic presses and cylinder actuated machinery without aid of large cylinder assemblies, provides single source of high pressure and high volume, provides instrument for field of hydraulic production test equipment and for experimental test field, and eliminates intensifiers and accumulators in hydraulic circuits up to 5,000 psi. It is supplied in two models: constant- and variable-delivery types.—**AVIATION, May, '46**

Aluminum Cleaner 65

New material, Formula 32, made by **Kelite Products**, Los Angeles, is semi-thick liquid aluminum cleaner applied by mop or swab directly to oxidized and dull aluminum aircraft surfaces. Rinsing following this operation produces clean bright natural finish quickly ready for protective polishing or painting. Complete process includes use of high speed solvent action alkaline cleaner which is free rinsing in water and safe on aluminum, to prepare surface for de-oxidizing.—**AVIATION, May, '46**

Three-Core Solder 66

A continuous supply of non-corrosive flux is present in Tri-Core Solder developed by **Alpha Metals**, Brooklyn, since cores are independent of each other. With three cores, occurrence of dry sections in more

than one core is mathematically impossible, maker states. Arrangement of cores places them nearer surface, and since walls are thinner solder melts quicker and heat penetrates to flux more rapidly. This solder is available in all alloys, flux percentages and gages.—**AVIATION, May, '46**

New Type Manometer 67

Consisting of two separate manometer tubes in same case, each tube with individual well, new manometer "Dual Tube" Model 109, made by **Meriam Instrument Co.**, Cleveland, enables operator to read high range of pressures, vacuums and differentials from floor level. Left tube has scale increasing upward and right tube has scale increasing downward. Both tubes are connected in parallel to same source. Instrument available in ranges of 40 to 140 in., can be used as calibrating standard manometer in checking flow meters, pressure gages and other secondary units operating on pressure or vacuum principle.—**AVIATION, May, '46**

Adjustable Quadrangle 68

New plastic drafting tool incorporating new features is quadrangle made by **Stewart Jackson Instrument Co.**, Los Angeles. Giving angles from 0 to 90 deg., pitch scales from 0 to 24/12 percentage

slopes from 0 to 100%, and sine or cosine functions and tangents, instrument has eight drawing edges, is rectangular in shape, and may be used as a triangle. Body and arm are blank so draftsman may add his own most-used cutout symbols and measuring scale. Size is 4 x 11 in.—AVIATION, May, '46

Thread and Gear Measuring Wires. .69

Supplied in sets of three contained in glass bottles labelled to show size of wire and wire constant corresponding to number of threads per inch, new line of thread

and gear wires made of cemented carbide is announced by Lincoln Park Industries, Lincoln Park, Ill. Wires for N.S. 4 to 36 pitch are available from stock. Wires for other pitches are supplied on special order. —AVIATION, May, '46

Rapid-Process Photo Papers. 70

Two new photo printing papers are now available which enable production of true scale copies easily and quickly, states Eastman Kodak Co., Rochester, N. Y. Named Kodak Resisto and Resisto Rapid, they have bases impregnated with acetate which sheds water. Development is stated to require 1 min., fixing 4 min. and washing 4 min. Smooth and white in finish, paper is offered in both contact and projection printing types.—AVIATION, May, '46

Aircraft Grease 71

Designed for lubrication of aircraft, new general purpose grease, "Regal Starfak Special", made by The Texas Co., New York City, is reported to provide satisfactory lubrication between —40 and 350 deg. F. Grease can be used on landing gears, wheelbearings, control bearings, propeller hubs, and magneto and generator bearings and gears.—AVIATION, May, '46.

Lightweight Check Valve. 72

Greer Hydraulics, Brooklyn, announces new simple lightweight poppet-type check valve. Unit consists of valve housing, hol-

ANNOUNCEMENTS—

of new machinery, shop equipment and materials, electrical appliances, and aircraft parts and field units are invited.

In writing, emphasis upon specific aviation applications of newly marketed items is desirable. Also, whenever possible, glossy-print photos should be enclosed. Please do not send electros. Address—

New Products Editor, AVIATION 330 W. 42d St., New York City 18

low aluminum alloy poppet aluminum alloy poppet guide valve spring and retaining ring There are no moving parts except for poppet and positive opening and closing action —AVIATION, May, 46

Electrical Appliances

Miniature Meter 73
Stated to be accurate enough for applications in high quality equipment, sealed miniature meter has been developed by **MB Manufacturing Co, New Haven Conn.** It has moving coil of 1 in dia. Scales are lithographed on metal in 10 20 or 25 line rulings and meter is stated to be accurate to 2% of full scale deflection at any point Model 102 available in dc ranges from 0-200 microamp through 0-50 milliamp and 0-50 millivolts and mounts through 1 in opening Model 1-2 mounts through 1½ in opening and is available self contained in all standard dc ranges and rectifier and thermocouple type of instrument —AVIATION May, '46

Small 2-HP. Motor 74
Designed for aircraft and other applications new 2 hp EEMCO motor is made by **Electrical Engineering & Mfg Co Los Angeles** With armature speed of 5000 rpm it can be supplied with its output shaft speed by means of integrally built gear reducer which adds 2 lb to basic weight of 1¼ lb Motor is of ball bearing type with glass insulation and high temperature varnishes Stated to operate in continuous duty with temperature rise of 75 deg C over ambient temperature of 25 deg C it is offered for 24, 32, or 110v dc —AVIATION May, '46

Volt-Ohm-Milliammeter 75
Made by **Hickok Electrical Instrument Co Cleveland** new instrument Model 203 is designed to accurately measure wide ranges of capacity resistance ac and dc current and voltage as well as inductance High input impedance prevents loading when making voltage measurements Electronic ohmmeter is stated to permit measurements from 1 0 ohm to 10 000 megohms. Damage due to overload in voltage is said to be impossible —AVIATION May, 46

Aircraft Parts & Field Units

Hydraulics Remote Control 76
Air Associates, Teterboro N J announces new remote control for hydraulic equipment called Hydro-Switch System, composed of either small panel or pedestal mounted switch and new type valve located near equipment to be moved at switch with valve located integrally in actuating cylinder New device utilizes hydraulic flow providing all hydraulic system Two lines, plus drain line connected to hydraulic return provides four-way operation Maker states unit weighs considerably less than other types and lines are not over 1 in (size is indicated in photo by com-

parison with cigaret). System provides for control of actuated devices at any desired position and permits sequence of operation of equipment. Without restriction to any specific operating pressure it can be used in standard aircraft systems of from 1,500 to 3,000 psi as well as higher or lower pressures.—AVIATION, May, '46

Hydraulic Control 77

Having numerous applications including throttle, mixture, governor and other position indicators, small hydraulic remote control is offered to aviation market by Sperry Products, Hoboken, N. J. Transmitter and receiver are made of brass and together weigh 2½ lb. Any motion of transmitter arm will be duplicated by receiver arm. Either arm may be moved through 66 deg and receiver arm can be drilled at any location to produce desired linear travel of actuating arm. Transmitter and receiver may be connected by as much as 8⅛ ft of tubing.—AVIATION, May, '46

Axle Jack 78

Designed with 200 sq in base area for use on soft concrete, etc., 25-ton axle jack made by McCulloch Mfg. Methods, St. Albans, N. Y., has shut height of 18 in and ram lift of 8 in. Mechanical safety nut protects lift for entire range and double

cylinder pump raises ram under load. Parking and main air adjustable from outside. Pad on ram is replaceable. Aircraft wheels and brakes may be removed while strut is on jack without disconnecting strut hydraulic system.—AVIATION, May, '46

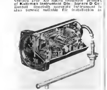
Portable Air Conditioner 79

Combination heating and cooling unit for air conditioning planes on ground is mounted in a closed truck body and can be attached to any cabin aircraft. Made by Pacific Airline Equipment Co., Huntington Park, Cal., it is rated to reduce temperature inside plane from freezing to 72 deg in 9 minutes and to drop inside temperature 10 to 15 deg from 100 deg in same time. Two

craft can be heated or cooled simultaneously. Additional use is for workers comfort in planes at hot weather terminals, for hangars and storerooms in case of breakdown or lack of heating systems and for conditioning sleeper planes where arrangements are not available for passengers at field. Perishable freight loads may also be conditioned with this unit.—AVIATION, May, '46

Airspeed Indicator 80

Now offered commercially is war developed True Air Speed Indicator, product of Kollsman Instrument Div., Square D Co., Detroit. Specially accurate instrument is also termed suitable for installation in



cabins for information of passengers, oversized models having been developed for this purpose. Unit embodies readings of air speed indicator, altimeter and air thermometer combined in one interesting assembly.—AVIATION, May, '46

Ignition System 81

Uni-power, now being produced by **LaPointe Plascomold Corp.**, of Unionville, Conn., is unified ignition system for aircraft. It is a single unit battery ignition system in which coil, condenser and distributor have been combined in molded plastic case. System is rated to eliminate interference and wiring as well as external coil with high tension lead. Weight is about 2½ lb.—AVIATION, May, '46

Airport Baggage Cart 82

Hammond Mfg. Co., Huntington Park, Cal., announces new baggage carrier for use at airports. Made of aluminum and lined with plywood, its cap. is 1,200 lb and measurements are 3 x 6 ft. Cart which

has retractile couplers fore and aft for convoy use, also may be used with fork lift type trucks. Standard equipment: Chrome bumper, Bassick foot operated locks and manually controlled brakes.—AVIATION, May, '46

Aircraft Range Receiver 83

First of a line of aircraft radio equipment to be made by **Electronics Div., Magnire Industries, Bridgeport, Conn.**, Model AR-1 is now in production. Originally designed for permanent installation as sole radio equipment for lightplanes or as standby equipment on larger planes which have two-way radio, it is adaptable for portable installation in all types of craft since batteries are contained in case with receiver and there is only one external plug-in connection. Set with tubes and batteries weighs 3 lb 10 oz. and measures 4⅛ x 4½ x 8⅜ in. Under average conditions, range of unit is stated to be better

than 150 mi. In addition to weather and tower, it will receive radio ranges in 190 to 420 kc. frequency band.—AVIATION, May, '46.

Ground Station Transmitter........84

Latest contribution to aviation communications by **Federal Telephone & Radio Corp.**, Newark, N. J., is general purpose ground station radio transmitter designed for low, high and very high frequency voice and CW transmission. Type 184 has been designed to meet wide range of operational requirements by combination of radio frequency units, power supplies, modulators, and accessories for local or remote control in bands 200-440 kc., 2-20 meg., and 108-140 meg. Transmitter has unit construction with accessibility to all interior compartments. Cabinet 74 in. high, 44 in. wide and 27 in. deep, will accommodate four RF units, two power supplies, two modulators, keyer, and control panel. Rated output in 2-20 meg. band is 300w; in 108-140 band, 300w. Unit rated over 150w. in 200-540 kc. band will be available soon. Transmitter operates on 220v., 50-60 cycle, single-phase current.—AVIATION, May, '46.

Aircraft Transmitter............85

Weighing less than 20 lb., No. 17K-1 aircraft transmitter made by **Collins Radio Co.**, Cedar Rapids, Ia., has five frequencies and is crystal controlled for use in 122-132 mc. band. Unit may be located anywhere

in plane and antenna relay is available for operation of receiver. Power output is 5w. Audio circuit employs peak clipping to raise effective modulation level and allow full use of carrier power. Company also announces Model 17E-2 125w. transmitter for executive planes.—AVIATION, May, '46

Aircraft Radio..................86

Designed to utilize both low frequency and high frequency (VHF) airways facilities, new two-way personal plane radio developed by **Belmont Radio Div., Raytheon Mfg. Co.**, New York City, measures 5¼ in. wide, 14½ in. deep and weighs 14 lb. By incorporating fixed tuned VHF channel on

75 mc. for receiving fan and "Z" markers, and continuous tuneable coverage from 195 to 410 kc. and 548 to 1,600 kc. satisfactory communications and navigation are available in one unit, maker states. Loop antenna may be added to provide radio DF navigation. Transmitter operation is on standard private aircraft frequency of 3,105 kc. Radiophone will be available in three models to operate from d.c. input of either 6, 12 or 24v.—AVIATION, May, '46

Radio-Telephone..................87

Suitable for traffic control at small airports and as emergency equipment at large terminals, radio-telephone Type 131-TR, made by **Erco Radio Laboratories**, Hempstead, N. Y., is available for 6, 12 and 32v. d.c. or 110v. 50/60 cycle a.c. Range is stated to be 200 mi. Power output is 15 to 22w. in the 2 to 6 mc. band.—AVIATION, May, '46.

ADDRESS New Equipment Data To— New Products Editor, AVIATION 330 W. 42nd St. New York City 18

Airline Earnings

(Continued from page 43)

type of service the airlines aim to provide postwar.

An unprofitable trend in express traffic also is complicating the picture. Sharply competitive conditions in air freight rates have resulted from the establishment of dozens of non-scheduled services by returning veterans. Already there has been a drop of 50% in planeload rates on cargo.

When air freight was launched in 1944, the rate was 60c a ton-mile. American and United now are quoting 15c per ton-mile on fresh fruit and vegetables, while non-scheduled operators are quoting rates as low as 12c. Plane-load rates may fall as low as 11c a ton-mile as increasing numbers of four engine transports become available to the lines.

This air freight situation may typify the sharp increase in competitive conditions just ahead, as lines open new routes and receive additional flying equipment.

Then, in 1947, the air carriers will be confronted with another test period as they take delivery on over 350 planes, mostly in the twin-engine medium range class. The airlines have committed themselves for $350,000,000 in equipment to carry their postwar traffic. That means more than 1,200 transports in service by the end of 1947 with a total of 40,008 available seats. Already there are those who feel that the airlines may have overestimated future air travel demands and obligated themselves for more passenger capacity than they can utilize economically.

A total of 40,000 available seats, trade officials point out, reflects an anticipated volume of 17,500,000,000 passenger-miles a year, figured at 60% of capacity demand. In contrast, the airlines flew only 3,500,000,000 passenger-miles in 1945.

Yet some of the more optimistic airline people are not unduly concerned over the above figures. They have witnessed the phenomenal growth of their industry, first during the depression years and later in wartime. They are ready and willing to take the gamble. By 1948, Pan American Airways, for example, will have a passenger capacity between the West Coast and Hawaii that will be well over twice the traffic demand ever experienced on this route in normal times. But never before has the public had the opportunity to make week-end trips to Hawaii. Accordingly, Pan American isn't worrying.

A survey of some of the problems challenging airline management in this readjustment period would not be complete without calling attention to the changing picture in the capital structures of concerns in this rapidly growing industry.

American Airlines and United Air Lines, among others, are planning to double their capacity this year. The stockholder will have to pay a price for that huge expansion—the dilution of his equity in the company's capital structure. American Airlines, for example, plans $80,000,000 of financing this year. Eventually all that and more, too, will come back to the shareholders in the form of expanded revenues. But for the first year or two it may be a bit difficult to show as large earnings per share as formerly. Trouble is that the lines must make large outlays for equipment this year, instead of waiting a year or two when the returns start coming in on their expanded fleets.

Again using the example of American Airlines, in 1940 the capitalization of this company consisted of 50,000 shares of preferred stock and 380,265 shares of common stock. Stockholders now have authorized an issue of 600,000 shares of preferred stock, while the outstanding common, after stock split-up, will amount to 6,432,840 shares.

Some observers question whether the airlines can exercise sufficient control over expenses this year to ward off an earnings decline. If not, those who paid high prices for airline stocks in relation to present earning power may be considerably disappointed at the 1946 results. But the airline investor who bought his stock with an eye to future growth will have no reason, over the long-term, to be concerned about the progress of this young industry.

To date, the airlines certainly have handled themselves much better than most young industries. In the business sphere, however, it is never wise to be "previous" in our outlooks, hence there's pertinence in our reappraisal of the airlines' financial avigation for the next six months or so. We should not expect too much too soon.

Lightplane Insurance

(Continued from page 86)

ipsa loquitur (the thing speaks for itself), where the nature of the accident is such that it would not have happened in the absence of negligence.

The remaining 24 states have no specific aviation liability legislation, but in cases decided in many of these states (in New York, for example: 266 N. Y. Supp. 469) tort law is applied to hold pilots liable for damages to property on the ground even though they were not negligent in causing the damages.

Passenger-Injury Liability

So much for liability for damages to third persons and to property on the

ground. The plane owner's liability to passengers, however, is something else again—by all odds the heaviest liability to which the owner is exposed and as a result the most expensive to protect by insurance.

Passenger liability is based on tort law, and there is little statutory material to be cited. Absence of statutes covering this type of liability, however, only indicates that the courts have so well covered the matter by applying the doctrines of tort law that statutes have not been needed.

Most noticeable fact about statutory law on passenger liability is the absence of "guest" statutes applicable to aircraft. Several states have automobile "guest" statutes which provide that the owner will be liable to guest passengers only when he has been guilty of gross negligence. But only two states, California and South Carolina, have airplane "guest" statutes specifically providing that passengers who ride gratuitously in a plane as guests shall have no cause for action for damages against the pilot unless such pilot has been guilty of gross negligence.

The only other statutes on this subject—those of Arkansas, Georgia, and Pennsylvania—provide that the plane owner's liabilities to passengers shall be determined by the rules of tort law. And in the courts of states which have no specific statutes, the same rules would probably be applied. Mere absence of statutes does not reduce the owner's liability.

Very few cases involving the liability to paying passengers have been litigated, because it has generally been found more economical to settle out of court (generally for an amount in the neighborhood of $10,000) than to fight the case, since suits that have been pressed have resulted in rather large judgments for the injured party.

Some lightplane insurance underwriters feel it is bad sales psychology to stress statistics and statutes on aviation liability, believing people might thus come to feel that aviation is not safe and so would be discouraged from buying aircraft. While this may be argued in the case of *prospective* purchasers, it certainly does not apply to those who have already joined the ranks of plane owners. These latter, actually, are the only persons likely to seek out information about aviation insurance.

Other underwriters and many prominent aviation personalities, on the other hand, hold that it is more important that the flying public be fully aware of its responsibilities. On this side, also, might be added the old legal maxim, "Ignorance of the law is no excuse."

Unlike the "hull" insurance previously described, the coverages offered by liability insurance, also premiums, are uniform with all the aviation insurance underwriters. Shortly after V-J Day, all aviation underwriters announced substantial reductions in the cost of the various types of liability insurance. For the private plane owner the rates for some coverages are now approximately half the prewar rate.

Three types of coverage are obtainable: Property damage, public liability, and passenger liability. Well-to-do plane owners should purchase all three coverages with rather high limits in each, since they are exceptionally vulnerable to liability suits. Those not so well off should purchase coverage in as many types as possible, to the extent that they can afford the premiums. Costs of each type of coverage can best be evaluated in relation to the particular kind of protection provided.

Property damage. This liability insurance is one of the most important coverages every plane owner should have. It protects him in regard to "absolute" liability statutes, insuring him against costs of damages his plane may cause to another's property. Coverage against property damage liability with a $5,000 limit costs $12.50 annually for the private plane and $17.50 for a commercial plane. The minimum limit—$5,000—is sufficient to cover the average amount of damage done by a plane. Even the crash of an airliner seldom causes property damage amounting to that figure. Point here is that most accidents occur in the vicinity of an airport or in open country.

Of course, higher limits of liability may be protected by those who do not rule out the possibility of forced landing in a built-up area, and this protection can be bought for very reasonable increases in the cost. A $20,000 limit can be purchased for $16.25 a year for a private plane and for $22.57 for a commercial plane. Very few feel that higher limits can be bought extremely cheaply indicates that they will be seldom needed.

Public liability. Insurance of his liability to third persons outside the airplane—that is, public liability—is the second type of coverage. This protects him against damage suits which may be brought by individuals (members of the public), who have suffered personal injuries, also against suits brought following a death which is a consequence of the operation of his aircraft. Examples: A plane hits a car parked near the airport, injuring one of its occupants; a plane makes a forced landing on a golf course, injuring a player, or a spinning propeller strikes an airport visitor.

Because there is always the possibility of injuring or killing individuals whenever the plane is in the air or in operation on the ground, the plane owner should be protected by public liability insurance. Aviation insurance underwriters insist on public liability coverage

when either of the other two types of liability insurance is written. Minimum coverage with a \$5,000/\$10,000 limit (which provides up to \$5,000 for any one person injured, or up to \$10,000 for any one accident) costs \$10 annually for a private plane and \$15 for a commercial plane.

Passenger liability. Plane owners who intend to carry passengers should take out the third type of coverage—that is, for passenger liability, protecting against lawsuits for personal injuries to, or the death of, passengers carried in the insured plane. Passenger liability is a separate form of coverage because the nature of the risks involved is quite different from public liability. Public liability is encountered only when the plane is operated in such a way as to endanger persons outside the aircraft, whereas passenger liability exists from the moment the passenger gets into his seat. Since there is considerably greater likelihood of injury to passengers than of injury to members of the public, passenger liability insurance is considerably dearer than public liability insurance.

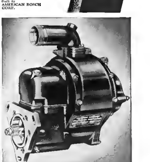
In 1939, 1,133 planes were involved in accidents in which a total of 31 passengers were killed, 36 severely injured, and 62 suffered minor injuries. Over 13% of all the accidents in that year involved injuries to passengers.

With these figures brought to his attention the private plane owner planning to carry passengers will readily see the advisability of taking out passenger liability insurance with at least a \$10,000 limit, since his liability for any one passenger killed or injured would likely run to as much as \$10,000 and could easily be much more than that. The well-to-do plane owner wisely will purchase higher limits of this type of protection.

Cost of passenger liability insurance depends upon the use that is to be made of the plane and upon the number of passenger seats that are to be protected. For instance, private-plane passenger liability coverage with a \$10,000 limit costs \$34 for one seat and \$47.60 for two seats. And if the plane is to be used by student and renter pilots the cost increases to \$61.20 for one seat and \$81.60 for two seats, while if the plane is to carry passengers for hire, the insurance will cost \$102 for one seat and \$147.60 for two. Costs named are per year.

Reason for the variation in cost of passenger liability insurance according to the use to be made of the plane is the greater degree of liability which the law assesses toward the paying passengers as compared to guest passengers. As we saw in reviewing the legislation in certain states, there *may* be liability to guest passengers, but there is *always* liability to paying passengers.

Summing up, it appears that liability



to passengers is the heaviest risk to which the plane owner is exposed and for this reason every owner who intends to carry passengers, either as guests or for hire, should protect himself with at least the minimum limit of passenger liability insurance. And to this should be added the amount of public liability and property damage insurance that the owner can best afford.

There is a new kind of insurance coverage called *single limit*, which the airport operator should bring to the attention of his interested owners. Under this new policy, the underwriter will defend the insured plane owner to the limit of one aggregate total amount against all suits arising out of a single accident. For instance, under a single limit liability coverage of $20,000 (which would cost the plane owner $68.97 annually) the insurance company will defend all public liability, all property damage, and all passenger liability suits, being responsible for claims against all three liabilities to the extent of $20,000. This type of coverage is becoming increasingly popular.

One important point that the operator will do well to stress to his plane owners is that under a policy covering any one of these three types of liability, or under a single limit policy, the insurance company will defend in the name of the insured any suit (whether groundless or not) included under the type of protection provided. Moreover, the company will pay the expenses of litigation, investigation, and settlement of claims, and will also pay for the immediate medical or surgical relief needed by the persons injured at the time of the accident. These payments are all in addition to the settlement of claims which come within the applicable limits of liability assumed by the terms of the insurance policy.

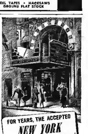
In brief, the amount of liability insurance which any plane owner should be urged to carry depends largely upon his affluence. Protection is an absolute necessity for the vulnerable wealthy owner, and he should be advised to take out complete coverage with rather high limits. Owners of more moderate means should consider liability insurance as a necessity in the course of operating their planes but since they are not as vulnerable to heavy damage suits, they may purchase coverage with lower limits.

North American Navion

(*Continued from page 95*)

435 lb of luggage in 46 cu. ft. of space. The ventilated cabin is 43 in. wide.

Dual wheel and pedal controls are fitted and basic instruments, fitted to rubber-mounted instrument panel, are given as follows: Non-sensitive al-



timeter, airspeed indicator, tachometer, oil pressure indicator, magnetic compass, electric fuel-level gage, ammeter, capillary oil temperature indicator, and fuel pressure indicator. An engine driven pump and emergency hand pump supply pressure for landing gear and flaps. The engine-driven pump and hydraulic reservoir are located in front of the firewall. A single unit consisting of engine hand pump, landing gear, and flaps selector valves is set forward of the control panel. Flaps may be hydraulically locked in intermediate positions, and a mechanical lock fixes them in the up position.

A 12v. d.c. electrical system is installed. Power supply includes a Delco-Remy generator of 15v. and 25-amp capacity, and a combined voltage regulator and reverse current regulator are also fitted. A 12v. battery of about 34 amp hr is installed, as is a Delco Remy electric starter.

A green position-indicator light is mounted on the instrument panel for each landing gear component, and each light illuminates when its respective component is down and locked. A red light and a warning horn will be actuated if any gear is either down and not locked or up and not locked. Navigation lights are also fitted. Space, wiring, and switch are provided for installation of landing lights, and structural provision and wiring are included for flares, 2-way radio, cabin heater, and any other additional instruments an owner might wish to add.

The engine is the 6-cyl. overhead valve, horizontally opposed, direct-drive Continental E-185, rated at 185 bhp at 2,300 rpm at sea level using 73 octane fuel. Although the prototype Navion has a fixed pitch prop, production models will have a variable airscrew.

Forward of the firewall are the engine and mount, accessories, air intake system, and cowling. The full-cantilever engine mount, made of formed aluminum sheet, is removable at the firewall and nose landing gear mounting beams. Shear type fittings hold the engine. A large air intake is located in the lower half of the cowl, with ducting to the rear of the engine. This ducting, with baffling, permits airflow upward across the engine, then aft over a baffle at the rear of the cylinders, then down to the engine-mount bulkhead. An air filter is included in the carburetor air intake, which is installed at the bottom of the engine mount.

The new and specially designed wing of the Navion is stated to give unusually fine aileron control at low speeds near the stall. The tip airfoil is declined 3 deg relative to root airfoil. Therefore, as the angle of attack of the wing is increased, the root sections are the first to stall. In addition, the tip section is provided with a marked amount of camber (lined up with the approaching streamlines), and any curvature from initial airflow is quite gradual.

All-metal semi-monocoque cantilever construction is used in the tail group, and horizontal stabilizers are fully interchangeable. The rudder has a ground-adjustable trim tab. All hinge points contain ball bearings, and it is stated that tail surfaces are easily removable.

Retractable tricycle landing gear utilizes air oil type shock struts, and the nose wheel protrudes slightly when retracted. Spring bungees attached to the gear have sufficient power to lower the gear if hydraulic failure should occur. The nose wheel is steerable through 20 deg., and the main wheels have hydraulic brakes. A steel-leaf-spring emergency tail skid is installed.

Although the Navion is planned for the personal or business pilot, the company mentions that the craft could also be used for carrying light cargo, or might be converted to specialized duties, such as photographic aerial surveying.

Tagging the Bases

(*Continued from page 91*)

Fifth Region—Reed Corstens, of Neb. Flying Farmers, now supervises farming operations on properties from Texas to Canada in his Aeronca Champion. . . . Eno Airport, Ft. Dodge, Iowa, is again being operated by Lt.-Col. Ellis E. Eno, formerly of 15th Air Force. All employees are vets. Firm is Aeronca, Stinson and Firestone agent, and field handles both 73 and 91 octane fuel. . . . Kans. Flying Farmers will gather at Hutchinson on May 24. Meeting is sponsored by local C. of C. and "Kansas Farmer." . . . Fulkerson Aviation Service, Gillette, Wyo., is agent for Aeronca, Bellanca, Continental, General Tire, B.G. ignition, Ranger radio, and Heath radio and accessories.

Sixth Region—At San Francisco NAA regional meeting under Chairman John Helms formulated plans for development of master airport plans, also a legislative policy regarding state aviation laws. . . . Axel Nielson of Lompoc and Arden Jensen of Solvang are planning another airport in Santa Ynez Valley. . . . Ventura Co. Airport at Oxnard, Cal., has now received designation from CAA. . . . San Bernardino, Colton, Redlands, Rialto, Fontana, and Bloomington, Cal., held a conference to select a site for an airline airport for San Bernardino Co. . . . Santa Barbara Co. board of supervisors recently voted to halt all airport construction in county until new zoning ordinance is passed. . . . Wesley Martin of Fixen Switch Airport, Yerington, Nev., provides free tie-down and transportation to town for visiting pilots. New hangar has been completed. . . . Airhaven Airports Assn., Phoenix, Ariz., has elected John F. Murphy as pres.

Seventh Region—Idaho State Normal School at Albion is now giving flight training, ground school and flight preparatory courses for college credits. . . . U. of Washington's Wing & Rudder Club has a student membership of 49. Club flies own Aeronca at Sky Ranch, Issaquah. . . . Moses Lake Aero Club, Wash., has been incorporated by R. W. Dial, W. J. McFadden, F. Driggs, O. D. Goodrich, R. Smith, C. Bedford and M. Zornes, all of Grant Co. . . . Forty-one Idaho pilots recently joined in a breakfast flight to Idaho Falls from Shelley, Salmon, Picabo, Twin Falls, Pocatello, Blackfoot, Ashton, Burley, Wilder, and Boise. Another breakfast flight was flown by this group to Pocatello. . . . Idaho Director of Aviation states that, of 84 towns having over 500 population, 34 are without flying facilities. . . . Oswald Flying Service, Tacoma, Aeronca agent, has employed Jack Burkhardt of that city to fly planes from factory.

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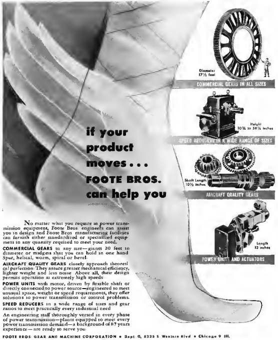

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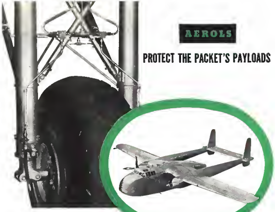

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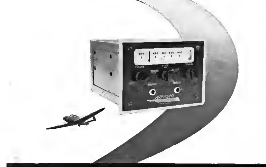

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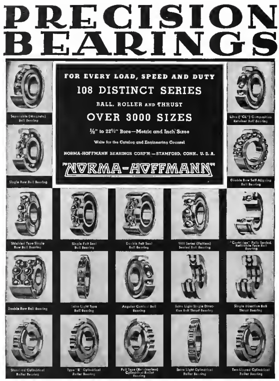
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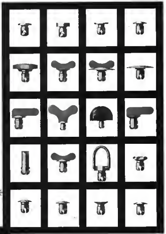

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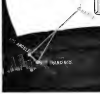

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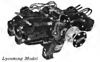

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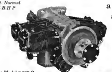

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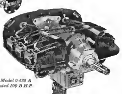

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help achieve simplicity and efficiency . . . in Hydraulic Valve design

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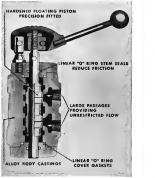

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Try this better way that saves you time and money.

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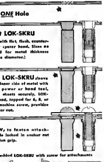
Complete Installation in Seconds



1 Drill ONE Hole

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RIVET · ANCHOR NUT · SCREW LOCK

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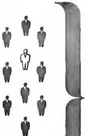

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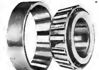

Airport crash fires are among the most vicious of all fires to fight. Army and Navy experience proved that they call for equipment able to reach any part of the field quickly . . . *with enough of the right extinguishing medium to deal effectively with the largest fires likely to be encountered.*

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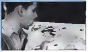

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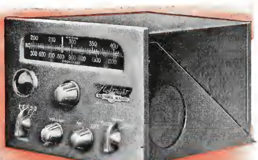
BALTIMORE 4, MARYLAND

WEST COAST BRANCH—1239 Airway Drive, Glendale, California



Type
PATR-10

*TRADEMARKS